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Radeon 6800 GROUP TEST

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HOW IT WORKS
INSIDE AMD'S ZEN 3 CPU

LABS TESTED: NEW MAC MINI, MACBOOK PRO & MAC AIR * APPLE'S NEW M1 CPU DELIVERS STAGGERING PERFORMANCE

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EDITORIAL

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EDITORIAL

An unexpected delight

Apple strong-ARMs the competition.

With its internally developed M1 processors powering the new MacBook, Air and Mini, Apple has hit it out of the park on its first swing. That's something none of us saw coming, and hats off to the team at Cupertino behind this mighty achievement.

When it was announced that Apple would be doing this, and leaving its long-standing chip partner Intel out of the mix moving forward, I think most people expected an Apple chip that was more in line with the sort of ARM-based performance we see in products like the Surface Pro X. That is, relatively low power use, and with Apple hopefully squeezing enough performance out of the basic ARM core design to do regular desktop tasks.

But, no. What we have here is a processor that comes as close as it needs to with raw processing power to go toe to toe against the competition – and especially compared to the Intel processors it ran before this new generation. It thoroughly boots them for battery life, and is as good as the best with its Integrated Graphics Processor.

It's an extraordinary achievement across three vital fronts – power, performance, and graphics. Of course it's far from Apple's first try at processor design, the company has been kicking goals with its A-series since 2013, and has been evolving these annually since then as they power many iPhones, iPods, iPads and the Apple TV very well. In that market Apple has been serving it up to Qualcomm for a very long time.

"One must wonder if the appealing aspects of the M1 are enough to make potential PC laptop buyers jump ship and go all-in with macOS"

But none of us expected a laptop and desktop (the Mini is arguably a desktop) processor good enough to seriously challenge equivalently positioned processors from Intel and AMD – and so thoroughly defeat the entire market for power consumption.

Joel's testing of the trio of initial M1 machines in this issue (starting on page 26) reveals some stunning numbers. *APC*'s best-ever battery life performer until now was the Dell Latitude 7400 2-in-1, which managed 14hr 17min. Along comes the M1-powered MacBook Pro, managing to keep its wheels spinning for an unbelievable 21hr and 40 minutes – with the Air not far behind. This is gobsmacking stuff. Over the years – nay, decades – laptop battery performance has crept up ever so gradually, with just minutes added for a new record, usually. And now... this! Wow. Good job, Apple.

Apple is already talking about adding more cores and improving the IPC, so that leaves AMD in a potentially worrying place – or may do in a year or two. Chip development takes years, and AMD has hefty engineering momentum right now.

Still, one must wonder if the appealing aspects of the M1 are enough to make potential PC laptop buyers jump ship and go all-in with macOS. Joel talks about app support in his feature story, and that's going to be a tougher bridge for ARM-based Apple to cross, but for now, today, if you want a personal computer that can run longer than any other, and has the processing and graphics chops to handle most things, then Apple is the top game in town.

BEN MANSILL

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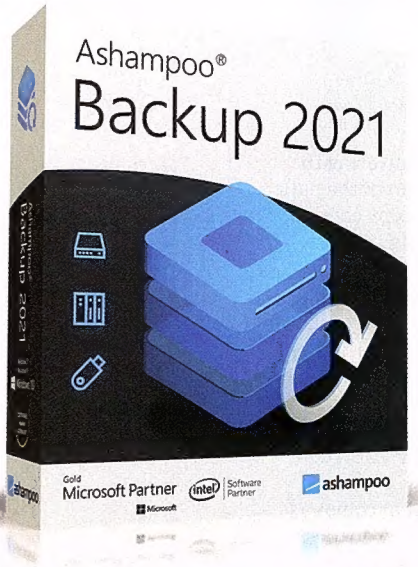

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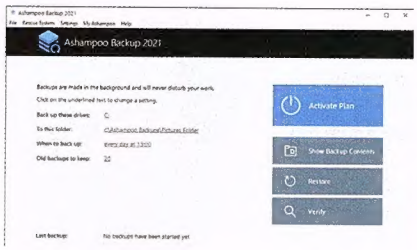

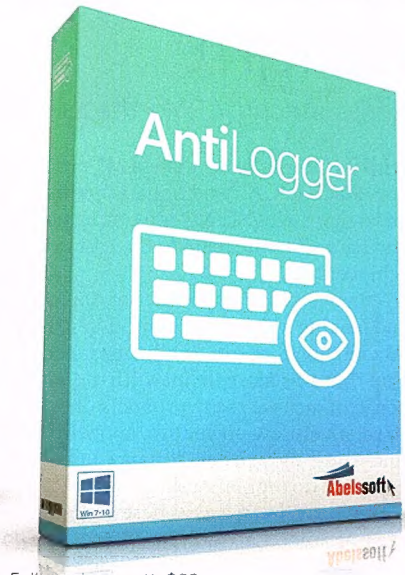

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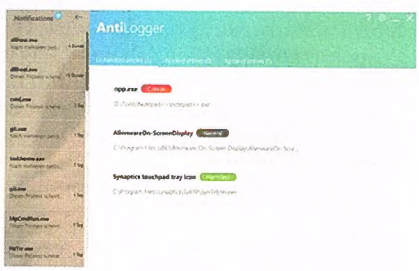

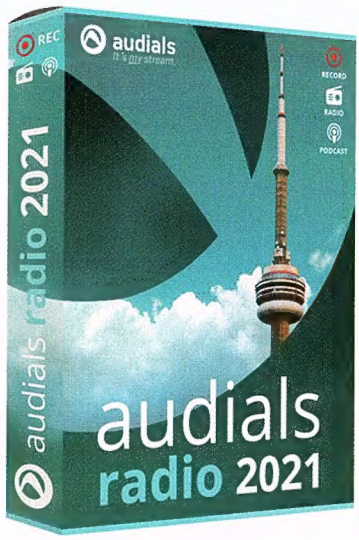

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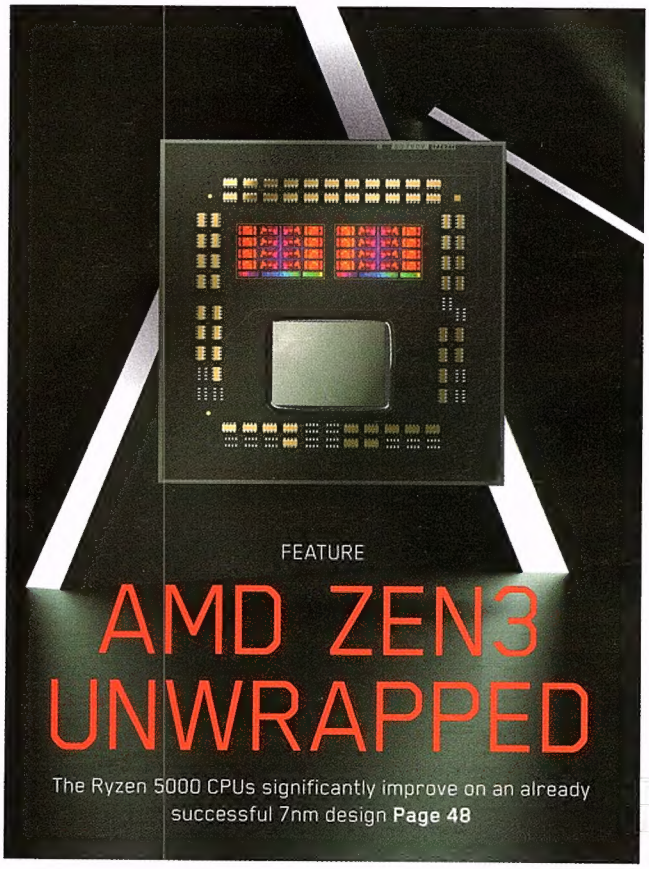

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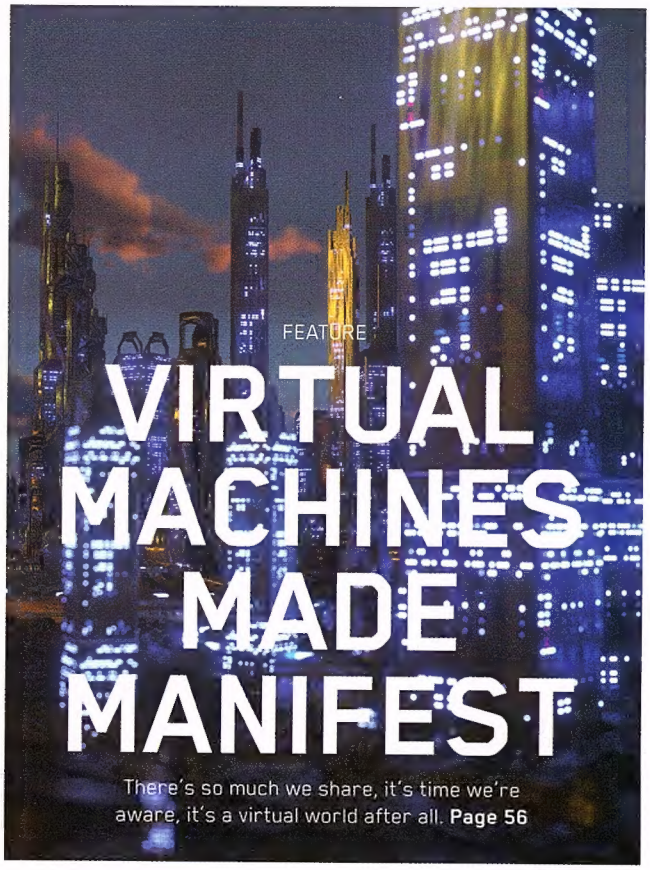

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Inside *APC*

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

"APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible."

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

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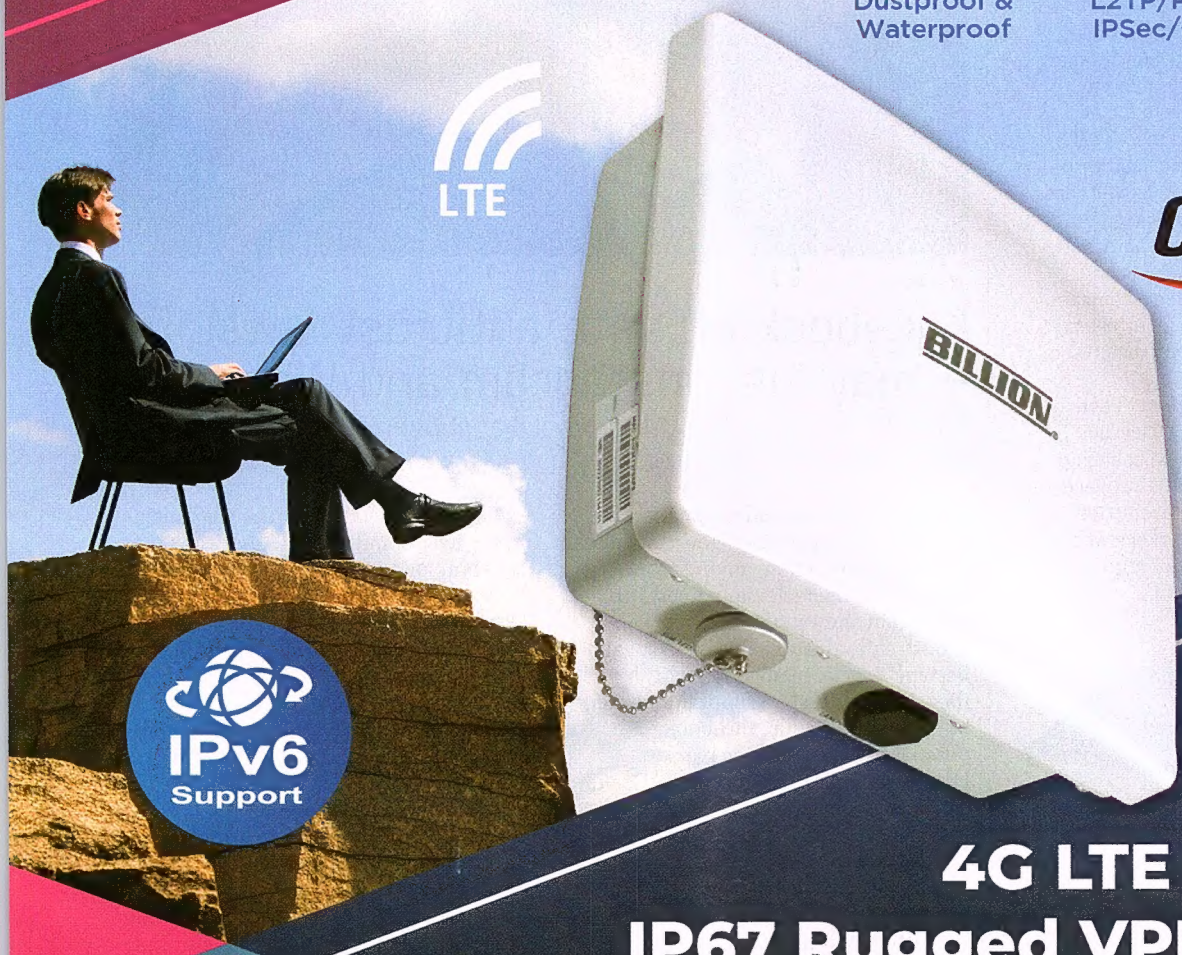

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TECHNOTES

ALL THE NEED-TO-KNOW TECH NEWS

Pic: NY Times

Google and Alphabet workers are unionising in the U.S.

Could further increase tensions between the company's engineers and the management.

A group of over 225 Google and Alphabet workers have announced that they have formed a union, aiming to make Alphabet a better place for all workers. The union, called the Alphabet Workers Union, has been formed with help from the Communications Workers of America's Campaign to Organise Digital Employees. Unlike a traditional union, the Alphabet Workers Union doesn't aim to negotiate for a contract. Instead, workers say it is an effort to give structure and longevity to activism at Google.

Unions have traditionally not been very successful in Silicon Valley, but things have recently started changing. Unions at Kickstarter and Glitch were formed early last year. A few months later, HCL Technologies workers who contract for Google in Pittsburgh successfully formed a union.

Pic: Intel

Intel tests mysterious Xe-LP GPU

Intel might have a maxed-out Iris Xe Max discrete GPU.

Listings in two benchmark databases reveal that Intel, or perhaps a company close to the chip giant, seems to be testing a rather mysterious unannounced graphics processor that has slightly more compute horsepower than the company's Iris Xe Max discrete GPU for notebooks.

Someone has submitted benchmark results of what is called the Intel Gen12 Desktop Graphics Controller featuring 128 execution units (EUs), clocked at 1.40GHz, and equipped with 3.03GB of memory. Given the 'Gen12' designation, the GPU is based on Intel's Xe-LP microarchitecture as other Xe microarchitectures are referred to as Gen12.x in the drivers. Since Intel's Xe-LP EUs are 8-wide, 128 EUs may be compared to 1024 stream processors of AMD or Nvidia GPUs.

BIG TECH

Facebook hit with antitrust lawsuits – may lose Instagram and WhatsApp

The US FTC and 48 states want Facebook to divest itself of WhatsApp and Instagram.

Facebook is facing two major antitrust lawsuits filed by the U.S. government and 48 states demanding, among other things, that the tech giant divest itself of Instagram and WhatsApp.

Both suits allege that Facebook has become a social media monopoly by illegally suppressing competition when it buys potential rivals. Facebook purchased photo-sharing platform Instagram for US$1 billion in 2012 and chat service WhatsApp for US$19 billion in 2014. Now, they are three of the world's most popular social media and messaging apps. Altogether as a company, Facebook is valued at more than US$800 billion.

In the suits, state and Federal Trade Commission officials are seeking an injunction that could force Facebook to divest assets, including Instagram and WhatsApp, and seek prior approval for future deals.

"For nearly a decade, Facebook has used its dominance and monopoly power to crush smaller rivals and snuff out competition, all at the expense of everyday users," said Attorney General Letitia James of New York, who led the states' investigation.

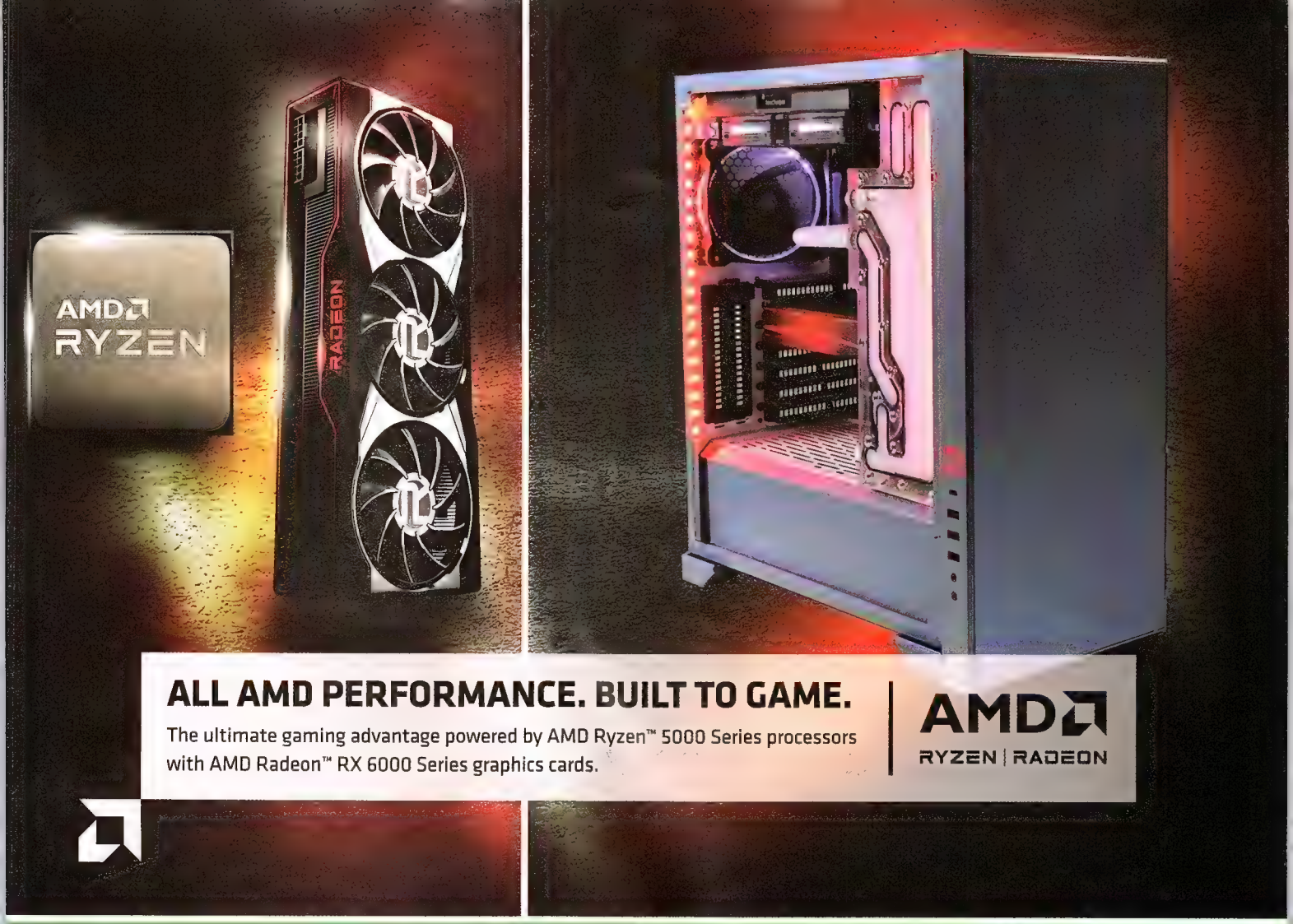
"Personal social networking is central to the lives of millions of Americans," said Ian Conner, Director of the US FTC's Bureau of Competition, in a statement. "Facebook's actions to entrench and maintain its monopoly deny consumers the benefits of competition. Our aim is to roll back Facebook's anticompetitive conduct and restore competition so that innovation and free competition can thrive."

CEO Mark Zuckerberg has previously called a breakup of the company an "existential" threat. And the Twitter account for the company's communication arm blasted the decision.

"Years after the FTC cleared our acquisitions, the government now wants a do-over with no regard for the impact that precedent would have on the broader business community or the people who choose our products every day," the company tweeted.

The legal action come on the heels of growing scrutiny of Facebook and Big Tech in general. The FTC previously investigated Facebook's data practices after the 2017 scandal involving Cambridge Analytica; the tech giant was forced to pay a US$5 billion penalty.

" "For nearly a decade, Facebook has used its dominance and monopoly power to crush smaller rivals and snuff out competition, all at the expense of everyday users," said Attorney General Letitia James of New York."



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Far Cry 6 Standard PC Edition (digital download) is not yet rated. May contain content inappropriate for children. Please consult with ESRB.org, PEGI.info, or your regional game ratings organization.

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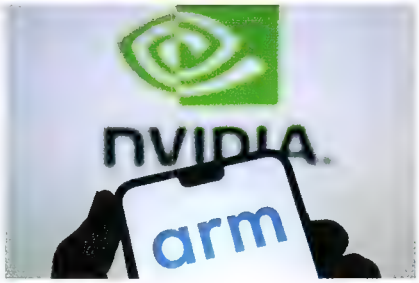
UBISOFT

Over 100 million PCs still run Windows 7 a year after Microsoft ended support

Windows 7 is holding strong, and actually gained market share.

Microsoft pulled the plug on general support for Windows in January 2020, ending what had been a 10-year run. But instead of withering away and settling into the footnotes of OS history, it is estimated that Windows 7 is still running on more than 100 million PCs, and perhaps way more.

Remarkably (or oddly, depending on your perspective), Windows 7 actually increased its share of the Windows OS market in December, according to data pulled by *NetMarketShare*. It went from holding an 18.78 percent share of all PC OSes in November to 19.71 percent in December. That's just shy of a full percentage point. It also amounts to one out of every five PCs running an OS that is no longer generally supported.



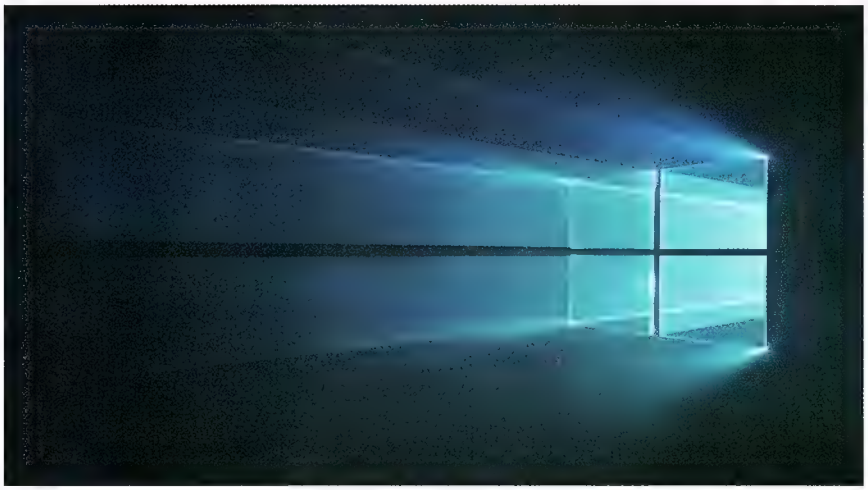
Pic: Shutterstock

Nvidia-ARM acquisition under investigation

Critics worry merger will stifle competition.

When it became public that Nvidia was in talks with ARM about an acquisition, some critics raised eyebrows, including ARM's Co-Founder Hermann Houser who called the deal a 'disaster.' When the deal went through, others expressed their concern about the merger's effect on the industry, and now, a few months later, UK authorities are investigating the US$40-billion purchase over concerns regarding competition.

ARM was purchased by Nvidia from Softbank, which had previously acquired ARM in 2016 for US$32-billion, but ARM failed to perform up to investor's expectations under Softbank's ownership. However, unlike Softbank, Nvidia has many competitors that work with ARM technologies, which is why the deal is subject to such intense scrutiny. Nvidia has made a vow to maintain ARM's neutrality and its open licensing model, but not everyone is willing to take Nvidia's word on it.



FRESH NEW BUTTONS

Microsoft's getting ready for some "reinvigorating" Windows 10 UI updates

The indicator? A sneaky job posting.

Microsoft has been planning some major overhauls for a while now. One such undertaking will be a big visual revamp, codenamed the "Sun Valley" refresh. It's set to be a major, and "reinvigorating" update to the operating systems UI.

The project will involve the modernisation of a host of Windows 10 UI features, including (but not limited to) the "Start menu, Action Center, and even File Explorer, with consistent modern designs, better animations, and new features."

This UI update comes as part of the "Cobalt" set of releases meant for "reinvigorating" the current Win10 setup, the bulk of which is set to roll out near the end of 2021. According to bleepingcomputer, a job listing has just surfaced on the Microsoft careers page, entitled "Senior Software Engineer." The key responsibilities for the role include "the opportunity to build delightful, polished, experiences for Windows," as well as "interfacing with hardware teams to build the essential platform and infrastructure in our OS." And with phrases like "open-ended explorations" dotted about it, it looks like the plans for Sun Valley are finally underway.

Ex-Intel and AMD chip guru Jim Keller joins AI startup Tenstorrent

On to the next challenge.

Jim Keller, a famed chip architect with notable stints at Intel, AMD, and Tesla, has joined AI chip startup Tenstorrent as President, CTO, and board member. The AI chip startup, based in Toronto, Canada, is designing new Grayskull inference processors for image recognition and voice processing tasks. Tenstorrent's approach melds high-performance inference processors with a new approach that uses AI to optimise low-level software functions, thus unlocking higher levels of speed and efficiency in an approach known as Software 2.0.

Keller had previous jobs at Tesla, where he served as the Vice President of Autopilot and Low Voltage Hardware, helped architect the Zen microarchitecture while he was AMD's corporate vice president and chief cores architect, and is also famous for designing AMD's successful K7 (Athlon) and K8 architectures. ■

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TECH BRIEF

Linus Torvalds blasts Intel for strangling the ECC memory market

Says ECC can permanently fix memory instability in the consumer space.

In a recent *Real World Technologies* forum post discussing error correction code (ECC) memory, Linus Torvalds, the creator of Linux, openly criticised Intel for not making ECC RAM mainstream on consumer platforms while praising AMD for supporting it on Ryzen platforms.

"ECC absolutely matters. ECC availability matters a lot – exactly because Intel has been instrumental in killing the whole ECC industry with it's horribly bad market segmentation. Go out and search for ECC DIMMs – it's really hard to find. Yes – probably entirely thanks to AMD – it may have been gotten slightly better lately, but that's exactly my point.

Intel has been detrimental to the whole industry and to users because of their bad and misguided policies with regard to ECC. Seriously. And if you don't believe me, then just look at multiple generations of Row Hammer, where each time Intel and memory manufacturers bleated about how it's going to be fixed next time."

Torvald's post continues with very colourful language, specifically calling out Intel for the lack of widespread ECC adoption in the consumer space. Torvalds says this is due to Intel's complete lockdown of ECC support on its consumer chipsets and processors, claiming that this alone has killed any incentive for memory manufacturers to create desktop ECC memory for consumers.

Linus does like stirring the pot periodically, drawing attention to important issues that he feels aren't being addressed.

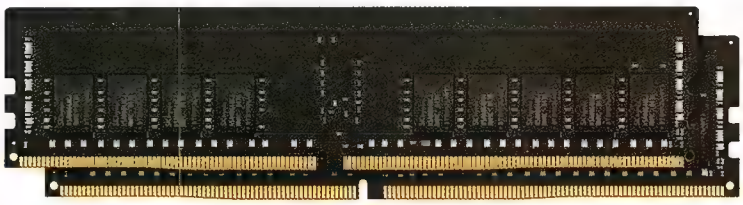
Linus also decries the Row Hammer issues that could be easily fixed with ECC memory. DRAM memory cells can leak their own charges into other memory cells. Usually, it's just a defect in system RAM that can cause memory errors, but Row Hammer attacks use that tendency as a mechanism to gain elevated system rights.

Torvalds also says that standard memory is a nightmare to deal with when developing code for the kernel of an operating system. Linus outlines the headaches of trying to find where an unexplainable kernel error happened, claiming that the errors could often be a result of a hardware issue and not a code issue – all of which could have been fixed with ECC.

Torvalds also praised AMD for unofficially supporting ECC. Even though it is unofficial support, Linus is still very happy that AMD even extends the option on mainstream consumer Ryzen platforms, giving consumers an option to use ECC without paying ridiculous amounts of money for server-class hardware. Whether or not 'unofficial support' is the best tactic to increase ECC adoption is up for debate (it often doesn't work correctly), but Torvalds obviously thinks it's a step in the right direction.

Torvalds hits on many good points – we wish ECC memory could at least be an option for all DIY PCs and pre-builts, especially for professionals that prize system stability. Memory can be critical for computer stability, as even the slightest number of errors can result in crashes or data loss. Unfortunately, standard non-ECC memory is always at risk for errors and is never 100% stable, even if that risk is often incredibly low. Hopefully, we'll see a push for ECC RAM to become a more viable option in the consumer landscape. ■

"Intel has been detrimental to the whole industry and to users because of their bad and misguided policies with regard to ECC. Seriously."



Pic: Apple

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END USER

When the biggest game of the decade goes bad

Cyberpunk 2077 was meant to be the future of gaming, but its developers were too reluctant to leave past hardware behind, writes Shaun Prescott.

For most of us, the year 2020 won't be remembered fondly: a global pandemic, a horribly polarised political climate, an outgoing American president with the personality of a three-year-old. So the fact that *Cyberpunk 2077* didn't end up blowing the world away after eight years of near unprecedented hype and marketing probably shouldn't be surprising: who expected something good to happen? (Psst: *Monster Sanctuary* was the actual best game of 2020).

But no one expected it to tank as badly as it did. Let's get one pertinent fact out of the way first: *Cyberpunk 2077* is actually a great game. It may not have lived up to "the hype" but it probably never could have. No, *Cyberpunk 2077* didn't tank in the usual sense of the term: by December 22 it had sold 13 million copies and recouped its dev costs. It tanked because a sizable portion of its audience basically couldn't play the game.

Advance copies of the PC version of *Cyberpunk 2077* were provided to reviewers about ten days before its launch. When the review embargo lifted, critics were mostly very kind to the game with only a handful of outliers. All noted the game's abundance of bugs and visual glitches, but that's not so uncommon nowadays. There's always the promise, especially with a proactive studio like CD Projekt Red, that bugs will be stamped out in the weeks following release. Games launching without bugs is more newsworthy than those that launch with them.

The trouble started several days later, when the game launched to the public. This was the same day critics received the PS4 and Xbox One versions of the game. As you can probably tell already, *Cyberpunk 2077* was an absolute mess on these seven year old consoles, and only marginally better on their 2016 mid-gen upgrades. In addition to regular crashes, the game's frame rate struggled appallingly during combat, with some footage showing frame rates dipping to the high teens. That's not to mention how fuzzy and ugly the game was compared to its PC counterpart.

SHAUN PRESCOTT
Author, PC Gamer editor and passionate technology observer, Shaun covers trending tech topics for *APC*.

"The fact that Cyberpunk 2077 didn't end up blowing the world away after eight years of near unprecedented hype and marketing probably shouldn't be surprising: who expected something good to happen?"

No one expected *Cyberpunk 2077* on console to look as good as PC, but they surely expected it to work. These consoles can still impress visually. A bit over a week after its release, Sony made the unprecedented move of removing the game from its digital console storefront and offering full refunds; Microsoft followed suit on refunds, but didn't remove the game from sale. It started to seem as if CD Projekt Red has tactically delayed public hands-on viewing of the console versions.

Thanks in part to the success of CD Projekt Red's *The Witcher 3*, *Cyberpunk 2077* was anticipated to the same extent that a new *Grand Theft Auto* game usually is. But in the months and years ahead of its release, not all press was good: the studio's crunch culture was well-known, and the company's policy flip-flopped from pledges to fix it, to admissions that it's a necessary evil. The game was subject to numerous delays, but that was to be expected of a hugely ambitious game, as this one was marketed.

Now, in late January, after reports of company in-fighting and blame shifting, and the filing of a class action suit for CD Projekt investors, the Polish studio probably isn't experiencing the post-launch glow it might have expected. It's no doubt a devastating state of affairs for all the development talent who worked on a game that, with more development time, would have launched to universal praise rather than condemnation. But it doesn't mean *Cyberpunk 2077* is a failure: look at games like *No Man's Sky* and *Sea of Thieves*, launched to a scornful audience, only to be redeemed with post-launch development. It's far from the end for CD Projekt Red, but it has its work cut out for it, and the affair may set a new standard for the public's attitude towards glitchy launches. ■

Pic: SearchEngineJournal

RANDOM ACCESS

Google's new union might actually help the company do good

The Alphabet Workers Union is promising to fight toxic culture, promote diversity and give employees 'a voice'.

Since removing the 'Do no evil' phrase from the forefront of its internal Code of Conduct in 2018, Google and its parent company, Alphabet, have clashed quite a bit with employees over what the company should or should not be doing. So it's perhaps not all that surprising that, after years of conflict, over 200 full time Google staffers and contractors voted to unionise in January, to have more of a say in the moral direction of the company.

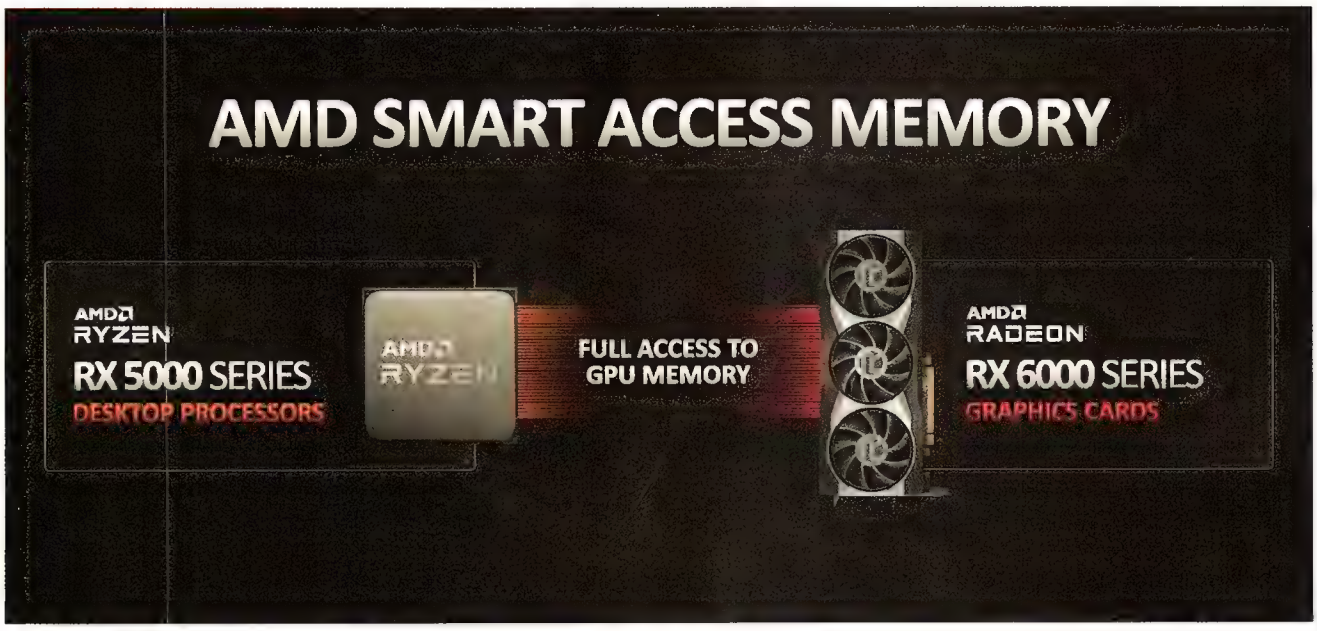
In 2018, an open letter signed by more than 3,000 Google employees protested the company's fulfilment of an AI image recognition contract with The Pentagon, known as Project Maven, stating that they didn't want Google to be "in the business of war". Then, a year later, thousands more employees signed a petition against the instatement of openly transphobic, right-wing think tank president Kay Coles, to a newly minted AI ethics board, citing a pretty obvious conflict of interests. In an act that most clearly distills Google management's reluctance for AI oversight, the decision was made to simply disband the entire AI ethics board following the outcry over nominees, rather than try to re-appoint positions, stating "in the current environment, ATEAC [Advanced Technology External Advisory Council] can't function as we wanted." The final straw came late in 2019 after Google fired one of its lead AI Ethics researchers over a disagreement on her participation in a scientific paper that outlines some major shortcomings of large language-training models for AI (i.e Google's main AI business).

In January, an op-ed in the *New York Times* by the recently elected Executive and Vice Chairs of the Alphabet Workers Union (AWU) outlined the union's goal to give employees the "power to control what we work on and how it is used." The AWU obviously also stands for general worker conditions, but it is also primarily concerned with encouraging diversity, stamping out harassment, and enforcing repercussions for workplace misconduct. Over 20,000 Google employees staged a global strike in 2018 after a *New York Times* expose detailed Google's US$90 million severance package to Android creator Andy Rubin after it became aware of credible sexual harassment claims – so it's not surprising that harassment issues are at the forefront of AWU's agenda.

JOEL BURGESS
When not reviewing PCs for *APC* and writing our funny pages, Joel likes to ponder tech and how it's used.

Since her departure from Google, AI Researcher Timnet Gebru has spoken at AI workshops about how a Google union might help prevent retaliation from big tech companies over ethics research. Even in the published email correspondence that directly led to Gebru being let go, she vocalises her frustrations at the poor levels of gender and racial diversity in the company and implores her colleagues to "stop writing your documents because it doesn't make a difference… there is zero accountability. There is no incentive to hire 39% women."

The rise of controversial applications like ClearView AI, which can identify anyone with a social media account from a single photograph in real-time on a smartphone, shows just how hard it is to backtrack on AI technology once it's created. Machine learning is progressing faster than perhaps any other technological field, but it's pretty clear from Google's missteps that in-house oversight isn't overly effective... so maybe AWU will help keep the company's AI development in check. At least until AI the field gets actual independent oversight. ■



TWO BITS

What is AMD's Smart Access Memory (SAM)?

It's been hiding in plain sight.

One of the touted features of AMD's new RX 6000 series cards is something it calls Smart Access Memory, or SAM. It essentially allows the CPU to access more of the graphics card's VRAM which can provide a decent performance boost. AMD claims it can boost performance by up to 10 percent, or even more in some cases. We ran a quick test using a couple of games and found mixed results. We did see a nice boost in *Shadow of the Tomb Raider* at lower resolutions and also *Borderlands 3*, but saw no change in *Metro Exodus*. This indicates that game engines need to integrate support to take full advantage.

SAM isn't an AMD exclusive tech. It's actually a PCI Express feature called Resizable BAR. Resizable Base Address Register, to use its full non-marketing friendly name, can be enabled via an optional motherboard BIOS setting. A portion of the GPU's memory is reserved for communication with the CPU and it's usually limited to 256MB. As the resizable part of the name indicates, with BIOS support, it can be increased to allow access to the full amount of GPU VRAM, which in the case of the current 6000 series cards, is 16GB.

If it was always part of the PCIe spec, why hasn't it been used until now? As AMD produces CPUs, motherboards and GPUs it was in an easier portion to develop and test it to see if it was worthwhile. PCI Express 4.0 bandwidth and the huge bandwidth on offer from modern GPU memory subsystems would certainly help too.

The motherboard makers label the feature a little differently in their BIOS. At the time of writing, support was limited to X570 motherboards. We'd expect AMD to roll it out for other chipsets.

That brings us to the main point. As resizable BAR is a part of the PCIe specification, it is not limited to AMD. In fact, Intel and Nvidia have both announced that they will implement this feature too. This means we'll have industry standard support and we'll likely get to the point where it's enabled by default when any discreet GPU is detected. It also means that game developers will integrate platform agnostic Resizable BAR support. Again, it makes you wonder, why didn't they do it sooner? It's been hiding in plain sight all along. A cynic might say AMD has been sitting on it until it was competitive at the high end!

So, if you're one of the handful of people from anywhere in the world lucky enough to have found a unicorn 6000 series card to pair with an AMD 5000 CPU, it's something that's definitely worth enabling. Everyone else (at least those with newer products) will get support soon enough, so why not enjoy a free performance boost? Do check to see if your particular game sees a benefit though. Some might actually see a small negative hit.

On a flimsy tangential note, I am the proud owner of a gorgeous 34-inch 3440x1440 144Hz Ultrawide monitor that I picked up during the Black Friday sales. It's stunning! The curvature is perfect and gaming is so much more immersive. I justified it by telling myself it would make me more productive, which was a total lie of course. Goodbye 16:9! ■

CHRIS SZEWCZYK
A life-long PC tech enthusiast, Chris has worked acoss the industry in many areas as a product and technology expert.

"It essentially allows the CPU to access more of the graphics card's VRAM which can provide a decent performance boost. AMD claims it can boost performance by up to 10 percent, or even more in some cases."

The race to 5nm

Moore's Law might be dead, or at least seriously slowing down, but progress hasn't stopped.

2019 saw AMD launch Ryzen 3000 CPUs and Radeon RX 5000 GPUs on TSMC's then cutting-edge N7 process, and 2020 brought us the Ryzen 5000 and Radeon RX 6000 chips on the same node. Nvidia opted for Samsung 8N for its RTX 30-series GPUs (and N7 for the datacenter GA100), while Intel still tries to get a handle on 10nm. The question now: Which company will be the first to release 5nm hardware?

If you want to count Apple, it already launched the first consumer 5nm chips built on TSMC's EUV-enhanced N5 node in October 2020. OK, maybe the A14 silicon doesn't count since it's not going into anything remotely PC. If that's your mindset, certainly the A14-derived M1 processor at the heart of the new MacBook line qualifies. Still, we want AMD and Nvidia – and maybe even Intel, if it outsources to TSMC – hardware manufactured on a 5nm node.

We don't expect it to happen anytime soon. Zen 3 and RDNA2 arrived late in 2020, along with Ampere. Even though Apple has been using N5 for a few months now, it looks like 2021 PC hardware will remain primarily focused on 7nm (or maybe 6nm) lithography. There are other options as well: TSMC N7, N7P, and N6 are all in production, with the latter functioning as a potential bridge between DUV (Deep Ultraviolet) and EUV (Extreme Ultraviolet) lithography. But TSMC's N5 is set to use more EUV layers, maybe 20 or more.

Based on the current state of affairs, the safe bet for 5nm PC CPUs and GPUs is AMD. We know both RDNA3 and Zen 4 are in the works, and both are expected to use TSMC N5. However, don't count Nvidia out – especially after it went and acquired ARM Holdings for a heartstopping US$40 billion. Subject to regulatory approval, sure, but Nvidia really wants its own CPU family, and ARM seems like the perfect fit.

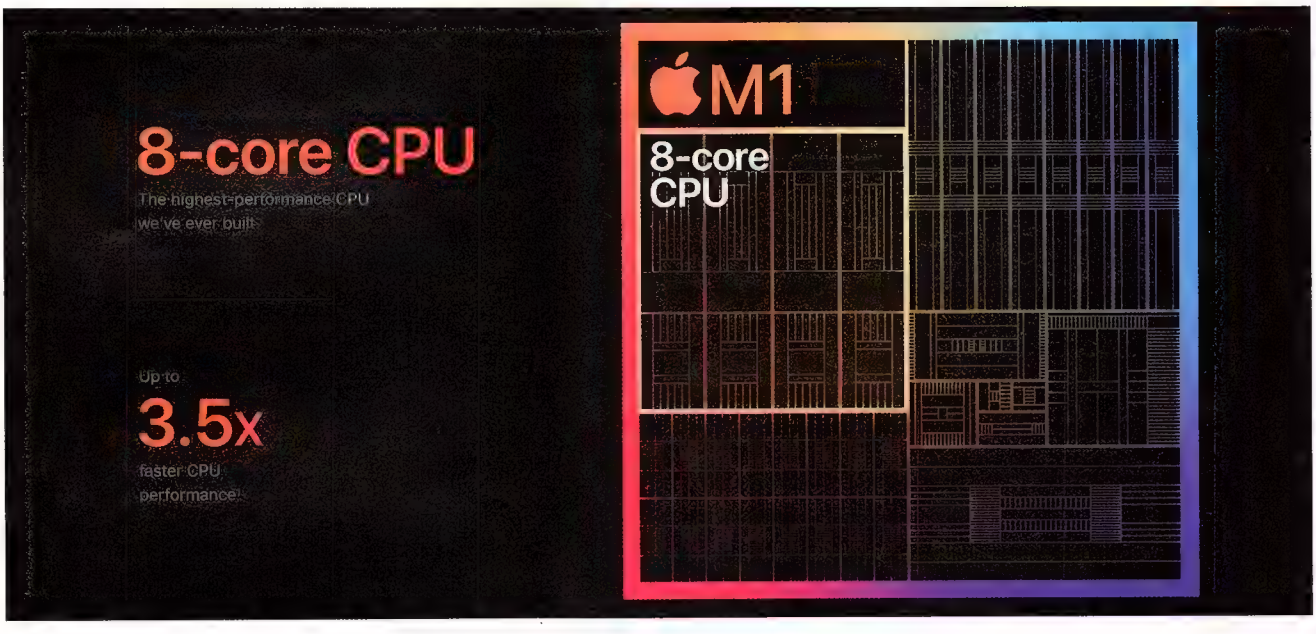
There's also the question of whether Nvidia got a bit too comfortable in the GPU space with Ampere. The Radeon RX 6800 series doesn't clearly beat RTX 30-series GPUs, but it's arguably as close as AMD has come since the days of the HD 7970. AMD still has the console wins that tend to encourage game developers to leverage AMD features rather than focusing on Nvidia. Perhaps Team Green will fast-track an N5 design, to put AMD back in its place?

Alternatively, and hear me out, Nvidia could start pushing to make a competitive ARM-based chip for Windows. Nvidia was ready to dabble in x86-compatibility with Project Denver in 2013, which would have leveraged binary translation to enable x86 code to run on its ARM CPU cores. Intel put the kibosh on that with legal and licensing deals, but x86 is probably as vulnerable as its ever been right now.

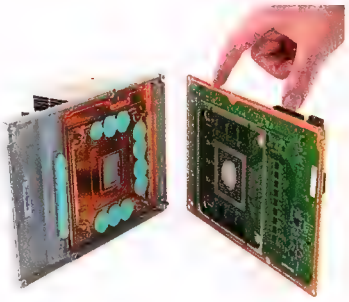
JARRED WALTON
Jarred Walton has been a PC and gaming enthusiast for over 30 years.

It's not like PC users would need to suddenly migrate to ARM and some alternative OS, either. Windows on ARM continues to gain traction, and Apple has just waved a big middle finger at Intel and x86. Wouldn't that be ironic, if Apple was one of the driving impetuses for Microsoft shifting more resources from x86 to Windows on ARM? That's probably still many years away, but for the mobile market, the x86 exodus is well under way.

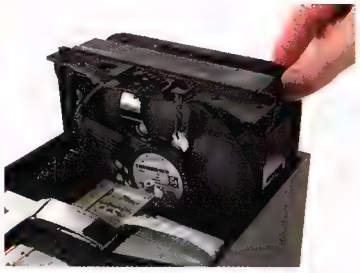
Even as mobile designs improve, there's still no getting away from desktop power. Nvidia has ambitions to displace x86 with ARM, but there will still be a place for desktops with chunky GPUs and CPUs. No matter how fast the next gen of smartphones and laptops become, zipping along on 5W to 20W SoCs, the easiest way to get more performance is to crank the power to 200-500W. With Mellanox under the corporate umbrella along with ARM, all-Nvidia servers and supercomputers are on the roadmap somewhere. ■



Apple technically already won the race to 5nm.



This thing is starting to look ever so similar to those GPUs *APC* is always taking apart.



Similar to the Corsair Ones, Microsoft is using a single fan to cool the entire machine.

Xbox Series X

The name might not be all that different from the last gen, but everything else is.

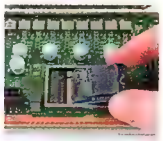
Buried in a blizzard of buzzwords like "teraflops," "true 4K," and "ray tracing" is a new device – Microsoft's statement on gaming for the next several years. It's teardown time.

MAJOR TECH SPECS

- AMD custom 8-core 3.8GHz (3.66GHz with SMT) Zen 2 CPU
- AMD custom RDNA 2 GPU (1,825MHz with 52 Compute Units)
- 16GB GDDR6 RAM
- 1TB SSD storage (with an optional 1TB Expansion Card)
- HDMI 2.1 connectivity with support for 8K video at 60 Hz, or 4K 120 Hz
- 4K UHD Blu-ray drive

KEY FINDINGS

- This year's flagship Xbox is rocking a fuller figure and serious cooling. More grilles grace the back of the console, along with the usual ports and a new storage expansion slot.
- Two bright green T8 screws suggest an official Xbox welcome into the machine, yet those screws are hidden under stickers and a trapdoor. Regardless, it won't stop anyone armed with our Mako driver kit. Spin the driver, pop a few clips, and in. We've got our crosshairs dialed in. Primary removal target? The beefy 130mm fan. It's pretty get-at-able for cleaning – a big plus. If your X stands up tall, this is upward exhaust.
- It's clear the Series X is built to run cool and quiet. Mounted up front is one of two antenna boards inside the tower. The redundancy might serve to ensure a solid connection in either of the console's two orientations.
- Moving along to a box within the box, we lift the power supply away from the main assembly. This PSU's primary rail outputs up to 21.25 amps at 12 volts, which equates to 255 juicy watts. Add the peripheral 60W output, and you get a total of 315 watts. The supply uses pricier, longer-lasting polymer capacitors instead of electrolytic ones to filter the 12V output.
- The Series X uses an M.2 2230 NVMe SSD, namely a custom 1 TB SN530 by Western Digital. We heard it's super-fast PCIe Gen 4.0, too. It's nice to see Microsoft using a replaceable drive here, even if software barriers prevent you from doing the replacing. Since this SSD comes in a standard M.2 form factor, we popped it into our desktop workstation for a peep at its contents. If you were expecting it to be partitioned a lot like the hard drives found in prior Xboxes, you're way ahead of us. Even though the SSD itself is fairly standard, if past experience is any guide, plan on some serious headaches if you ever need to replace or upgrade it in the future.
- It almost feels like an air conditioner with a graphics card. A relatively modular and repair-friendly design is overshadowed by some software barriers. Our tests indicate that both optical drive and SSD repairs will be problematic.
- Xbox Series X Repairability Score: 7 out of 10 (10 is easiest to repair). Very few tools are needed to disassemble the console. All screws are standard T8 Torx fasteners. The modular design allows for easy fan, optical drive, PSU, and wireless board replacements. The SSD is a modular, off-the-shelf part, but requires a bit of disassembly to access. Some critical component repairs are complicated by software locks. ■



Featuring PCIe 4.0. this bespoke WD drive should be fast enough, shame it's not easily replaceable.

APC's favorite peripherals of all time

08

Logitech G15 2006

Blue backlighting and a built-in LCD panel with macro support? The G15 was ahead of its time, but it does look truly dated now.

07

Corsair Void Pro 2017

Our resident staff writer was actually present at the Gamescom launch of this headset, and it has since proved to be an invaluable companion for daily online games.

06

Steelseries H5v3 2013

SteelSeries has always produced solid peripherals, and the H5v3 was no exception. Leather padding, a double-braided cable, and great portability set this headset apart from the crowd.

Logitech G502 Lightspeed 2019

It might be expensive, and more recent than other entries on this list, but the G502 Lightspeed is a simply sublime mouse that will take some beating.

05

04

Microsoft Sidewinder X5 2008

Remember when Microsoft made gaming mice? *APC* remembers. It might've looked weird, but the 2,000 DPI optical sensor made the X5 a great purchase at the time.

03

Razer BlackWidow Ultimate 2016

The 2016 "Ultimate" model came with Razer's signature green lighting and tactile orange switches, which were near-silent: perfect for late-night gaming.

02

Antec Soundscience Rockus 3D 2.1 Speakers 2010

This piece of kit was a high-quality three-piece desktop speaker system that was capable of rich, room-filling sound thanks to its forward-firing subwoofer and the dual satellite speakers.

01

Logitech C920 HD Pro 2015

Can you tell that we like Logitech's stuff? This 1080p webcam is still kicking around, because it was perfect when it came out and it's perfect now, even with the weird "logi" logo. ■

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GADGETS

NICE THINGS TO HAVE, FOR YOUR PC AND BEYOND

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LG QNED TV

LG's LCD tech is the new neighbourino for high res TVs.

LG is keeping OLED front and centre of its flagship offerings this year, but for most of us, 4K LED is where the value is... and for anyone in this space QNED is an interesting proposition. QLED is Samsung's leading LED technology that allows it to get better efficiency and contrast from a quantum dot filter over blue backlights, and it seems LG is interested in getting in on the action here by blending it with a NanoCell MiniLED backlighting aray. QNED – as LG's new-diddly-do mashup is called – uses 30,000 MiniLEDs to create 2,500 zones which will significantly boost dynamic contrast ratios, colour and perceived darkness.

$379 | bose.com.au

Bose Sleepbuds 2

Singing whales in your head helps you sleep better.

Insomnia can ruin your life. We know. Beating it can be difficult, and anything that's not a sleeping pill or vodka should be seriously considered as a solution. Like this solution from Bose. Now in its second iteration, the new Sleepbuds are not regular music buds, instead they play non-stop sleepy sounds stored in onboard memory all night long to drift you away. Wind in trees, rain on a roof, waves on a beach, white noise. That sort of hypnotic stuff. They're small and comfortable enough to not be too bothersome. The main idea is that they block out all ambient noise, so in noisy areas, or for shift workers, or on a plane they're great. For people with quiet rooms it's better to have your bedside speaker play sounds like this for a comfort win.

$119.95 | gopro.com/en/au

GoPro Smart Remote

Be the star and director with this new action camera remote control.

GoPro has always attempted to cater to the selfie videographer market that operates in challenging environments, but even these easy-to-use cameras are often out of reach if you're regularly starting and stopping recordings. Sure, you can engage the voice-activated recording features for some tasks, but the GoPro Smart remote has a range of up to 180m and gives you battery, storage space and shot type info all within easy reach. With 40 percent more battery than its predecessor and 10m waterproofing, the rugged remote can be with you pretty much anywhere.

$NA | artstation.com/artwork/q9Eabn

Dyson Motorbike

A concept motorbike that doesn't suck.

The company largely known for tricking you into thinking domestic vacuum cleaners are sexy sci-fi 'must-haves' got a bit of attention in 2019 when it released a concept electric motorbike, and one keen designer clearly wants to make this an annual trend. Automotive concept designer Rashid Tagirov whipped up this vortex-inducing electric motorbike design replete with see-through perspex windshield/heads-up display, hyperdymium motors and corrugated air-purifier filters (for the COVID, we suspect). The late 2020 concept also features a super-futuristic looking headlight that may or may not be entirely eclipsed by the front wheel. Oh well, I guess you don't need to see what's in front of you when you're this far ahead of the game.

US$599 | kck.st/2JXQUFe

LaserPecker 2

No, it's not a sci-fi porno.

While it might sound like the latest breakthrough in telidildonics, the LaserPecker 2 is actually a major update to the popular original laser engraving tool that smashed its Kickstarter funding goal back in 2019. In addition to being significantly faster than the original, the update also offers an expanded range of compatible materials including: metal, glass, wood, leather, cotton, paper, bread, fruit, bone, and just about anything else you can think of. It's also now capable of carving into a range of shapes including spherical objects like cylinders and can move while carving for longer patterns.

$249 (cam) | $99 (Solar Panel)

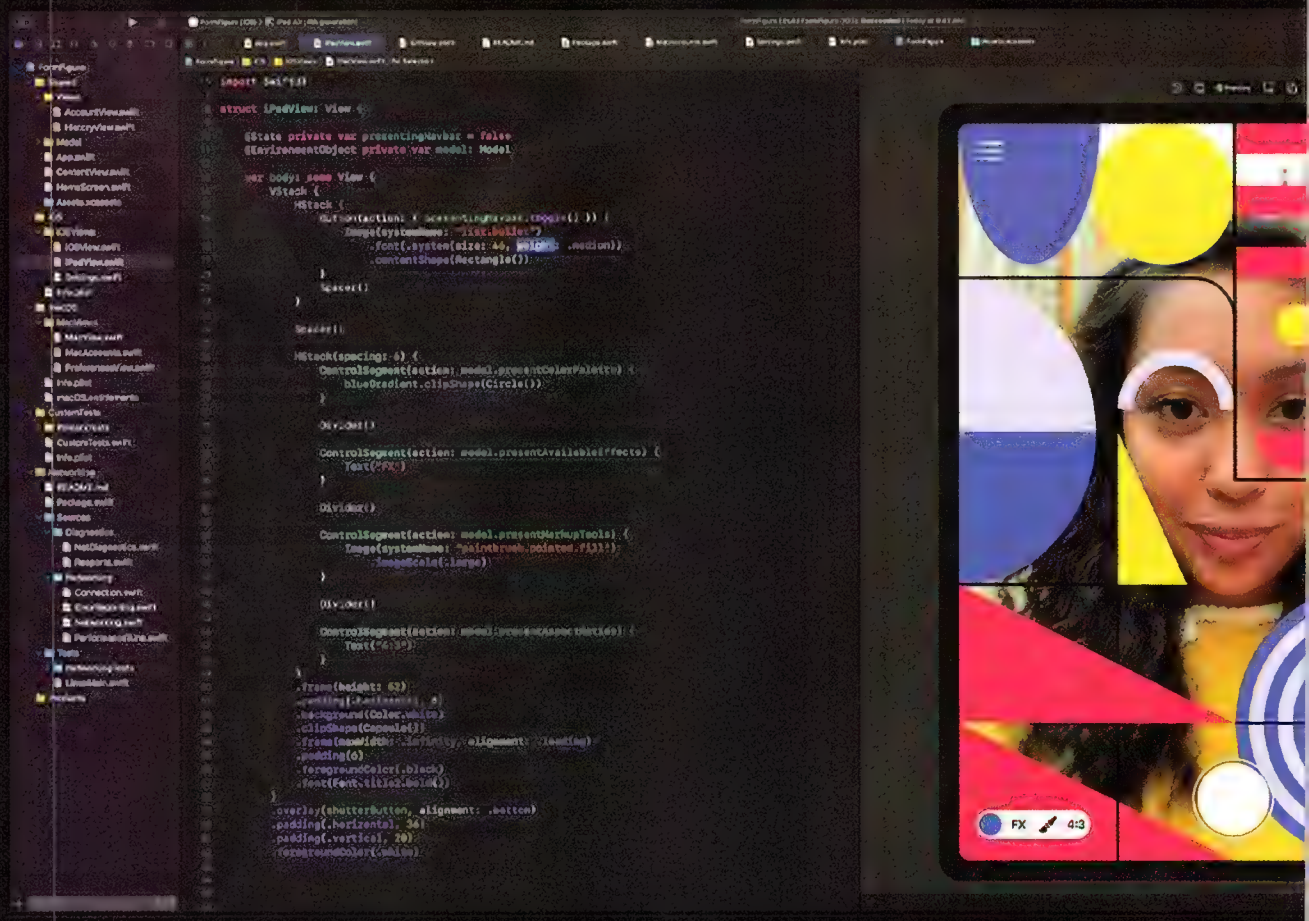
Uniden Guardian App Cam Solo Pro

The sunny side of security.

Installing a security cam can be a royal PITA – especially if it's being used outdoors. Cables are the enemy, both for power and carrying the feed. Keeping them tidy is troublesome, it all becomes a hassle if you're just renting, and there's the legitimate risk of sneaky thieves just cutting the cables (movies taught us that). But not this. The cam uses Wi-Fi to transmit, which isn't unusual – but what is extra nice is that it can be paired with the sold-separately solar panel to create a totally wireless installation. That makes it a delightfully neat setup, and adds an element of portability, or enabling a temporary installation, which is also a win. It has a colour night vision camera, a spotlight and heat and movement sensors. ■

REVIEWS

THE HOTTEST GEAR LABS TESTED



LABS FEATURE

APPLE M1 ARRIVES

Apple's first devices since ditching Intel are finally out, and the new M1 processor has fundamentally shifted the parameters of what's possible now, and in the future of ultrabooks. Joel Burgess prepares to be amazed.

In the Random Access section of *APC*'s last issue (Jan, #489) we took a look at some of the marketing claims surrounding Apple's first in-house mobile PC processor, known as M1. As the first entirely Apple-built laptop CPU, we expected some bold marketing spin to envelop the new chip, but we were surprised to find that a lot of the marketing claims were more straightforward and easy to quantify than what you generally get from a launch like this.

Big promises

First and foremost was the claim that CPU performance was up to 2.8 times the performance of the last generation of MacBook Pro laptops, and that the M1 chip would offer the world's best CPU performance per-watt. While there are a handful of devices that have used Qualcomm's more efficient Snapdragon 8XC chips as laptop processors, the ARM Reduced Instruction Set Computer market hasn't been broadly successful. Not only have these laptops taken a hit in processor performance, they've also thrown up some underwhelming results when translating 64-bit Windows 10 software designed for x86 architectures into code that's readable by simplified smartphone processors. So being the "fastest CPU core in low-powered silicon" isn't a particularly high bar. An ARM-based laptop processor that's 2.8 times more powerful than an Intel Core i5-1038NG7 CPU is, however, pretty remarkable. Especially when you consider it's the first laptop processor the company has ever mass produced.

But as big an accomplishment as this is, it's overshadowed by other more significant processing milestones, like the fact that the M1 chip does this using significantly less power and creating far less heat than traditional laptop processors. The M1 processor, paired with the standard laptop sized batteries in the MacBook Pro 13 and the MacBook Air models, is able to get up to 19 hours in movie playback tests… roughly double the average long-lasting ultrabook available for the last few years. So instead of getting one long working day lifespan, Apple's new devices have the capacity to last two or even three work days on a single charge when using light apps at medium brightness with sleep or off time in-between.

It delivers, and then some

Apple's M1 chip manages to land at least on par with Intel's impressive integrated Iris Xe Graphics and even supersedes it in a number of applications. Since we consider the Iris Xe Graphics to be capable of 'entry-level gaming' – any of the devices running Apple M1 chips will also be competent enough to run modern games compatible with macOS at Medium or Low near-1080p settings.

Apple is acutely aware of the troubles that other ARM-based devices had running some software designed for x86 chips in a 64-bit Windows 10 environment. The ideal solution is to design custom ARM-optimised software, and it has done this for a handful of in-house applications, but for everything else it's implemented a real-time translator that leverages the device's AI and transcribes code to make it compatible with the M1 chip. We haven't spent enough time with it to definitively comment on the success of this, but it is at least good enough to buy Apple the time to roll out custom technical applications as demand arises.

We haven't seen much in the way of downsides from the new M1 chip, and there's an entire raft of additional technologies and features that we haven't even touched on here. Even if we consider only the critical functions of a computer processor, the M1 is truly revolutionary and will distinctly separate Apple laptops over the next few years from anything we can see on the horizon.

apc HOT PRODUCT

From $1,999 | apple.com/au

Macbook Pro 13 (M1, 2020)

Apple's new processor has transformed the MacBook Pro 13 and set a new benchmark for ultrabooks.

While it's fair to say that the MacBook Air 13 gains the largest performance bump from the new M1 chip – if you break down the key new features for this machine, the update is nothing short of revolutionary. In addition to having more CPU power than its predecessor, the new MacBook Pro 13 also gains a transformative GPU upgrade, more than doubles its battery life, and lands at a significantly better RRP, without any real downsides. This might just be the biggest generational laptop update we've ever seen... Apple or otherwise.

Apple seems to be passing on a lot of the savings from its new in-house chips directly to consumers, since the MacBook Pro 13 with the M1 CPU, 8GB of RAM and a 256GB SSD starts at just $1,999. If you increase the RAM on his model to 16GB, then you'll have the most powerful Pro 13 for $2,299, a privilege that would have once cost at least $2,999. You can also opt for 512GB, 1TB or 2TB of onboard storage for an additional $300, $600 or $900 respectively.

There has definitely been a blurring of the lines between the MacBook Pro 13 and the MacBook Air this year since they now share the same processor, but there are a number of other features that help justify the higher price tag of the Pro 13. Perhaps most notable is the inclusion of the Touch Bar. Then there's the slightly brighter 500 nit 13.3-inch IPS display at 2560x1600 pixels that offers P3 compliant HDR colour for professional cinematic colour grading. The MacBook Pro 13's battery is around 17 percent bigger than the Air and it's got a bigger power adapter that'll charge the device faster.

In Geekbench 5 the MacBook Pro 13 has a 65 percent performance bump over the 2020 MacBook Pro 13, and in earlier Geekbench 4 multi-threaded CPU tests it was just 23 percent behind the most powerful Intel-Core-i9 MacBook Pro 16 of 2020. This is rather remarkable for something that's architecturally closer to a smartphone chip than a proper x86 PC processor, outperforming the best other low-powered silicon processor we know of: Qualcomm's Snapdragon 8xc Gen 2 on Samsung's Galaxy Book S, by more than 270 percent. The M1 chip offers 40 percent better multi-threaded GeekBench 5 performance over Intel's current Core i7-1165G7 CPU – which only just arrived on Dell's new XPS 13 and Asus's UX435 ranges. So it's essentially more than double the performance boost you'd expect from an iterative CPU upgrade.

Graphically the jump is perhaps even bigger. It got 37.6 fps averages on *Sid Meier's: Civilization VI* using Ultra settings at a 1440x900 pixel resolution. Sure, this resolution is lower than FullHD, but seeing as the device can get over 50fps at low graphical settings, it'll be able to play any modern game at near-1080p if you're willing to dial down the quality a little, which is a big milestone for an integrated GPU. Apple claimed its latest GPU was better than any other GPU on the market, and while we can confirm that it is at least as good as Intel's Iris Xe Graphics (an integrated GPU we've raved about in earlier issues), the race is still a little too close to call a definitive winner.

Battery life though, is a slam dunk. The longest duration we've ever had in continuous 1080p movie playback is around 14 hours, so for the powerful Macbook Pro 13 to get 18 hours and 46 minutes is game changing.

The MacBook Pro 13 (M1) offers a major performance bump, unbeatable battery life and entry level gaming for much less.
★★★★★

$1,599 | apple.com/au

MacBook Air (M1, 2020)

There might be a new Air to the best-value ultrabook throne.

Of all the M1 devices Apple released in this initial range, the MacBook Air is the one that benefits most from the updated processor. Now on par with the MacBook Pro 13, the MacBook Air is just 23 percent off last year's Core i9 MacBook Pro 16, which is a little bit ridiculous for a $1,600 passively-cooled ultrabook. It's also now the record holder for the longest battery life laptop we have on file. At 19 hours and six minutes in 1080p movie playback it's more than double the average current 'long-lasting' ultrabook lifespan.

The 13.3-inch Retina display is a little duller than the MacBook Pro 13's at 400 nits, but the device gets the same 2560 by 1600 pixel resolution and even includes the full DCI-P3 colour gamut for professional-level cinematic HDR colour grading. This means that it's a very viable contender for photographers and videographers that need an on the go workstation. We'd still caution that the MacBook Pro's additional thermal management architecture provides stability when running demanding tasks over long periods of time, but for shorter punchy tasks the Air will perform on par.

When you have them side by side, you'd undoubtedly choose the more subtle backlighting, softer key response and more harmonious proportions of the MacBook Pro 13 keyboard, but out of that context the Air's is more than comfortable enough to type on over long stretches. The same can be said about the speakers where both offer similar overall volumes, but when compared directly against the MacBook Pro 13's the Air sounds a little tinny at higher volumes. These subtle differences run through a number of other features and seem to create unique value between the two product offerings.

In Geekbench 4 the MacBook Air (M1, 2020) has a 70 percent performance bump over the earlier 2020 MacBook Air, and, similar to the MacBook Pro 13, it's over 40 percent more powerful than Intel's current Core i7-1165G7 CPUs in Geekbench 5. So we expect it to outperform all, but the most powerful gaming laptops this year, at least across the handful of cross platform CPU benchmarks available.

The $1,600 MacBook Air (M1, 2020) can also play a heap of macOS compatible Triple A games at moderate near-1080p graphical settings. While normally we'd recommend 16GB of RAM as the minimum for modern games, the 8GB M1 MacBook Air that we tested got 86.6 fps on *Total War Saga: Troy* using Low 1680x1050 resolution settings. So it seems, at least with Apple's Unified Memory which is built into the processor itself, you can get away with the base 8GB model for gaming.

These additional features are on top of a new 16-core Neural Engine for better AI processing, seamless integration with the new macOS Big Sur operating system, a well positioned fingerprint scanner and an improved HD webcam for both the new laptops here.

"The 13.3-inch Retina display is a little duller than the MacBook Pro 13's at 400 nits, but the device gets the same 2560 by 1600 pixel resolution and even includes the full DCI-P3 colour gamut for professional-level cinematic HDR colour grading."

A standout ultrabook performer with a 19 hour battery life at an unbeatable price.

★★★★★

apc HOT PRODUCT

From $1,099 | apple.com/au

Mac mini (M1, 2020)

Apple's compact desktop PC gets a GPU upgrade and a price cut.

Since it is permanently plugged into power, the Mac mini misses out on the massive battery life boost from the new M1 processor, but it does still get the performance benefits and a decent price cut – which means it's still a pretty impressive upgrade, on the whole.

Similarly to the MacBook Pro 13 range, you can still buy the Mac mini's Late 2018 predecessor with an 8th generation Core i5 or a Core i7 for $1,699 or $1,999, respectively – but we'd really recommend you don't. The new M1 unit performs around 10 percent better than the i5 2018 variant in Geekbench 4 benchmarks and is only beaten by the i7 model by a similarly close margin. When you consider that the new Mac mini range starts at $1,099 ($600 less than the i5 2018 Mac mini) we can't think of any reason why you'd choose its predecessor over the M1 variant.

Other than the more efficient processor, which uses 60 percent less energy than a Mac mini i3-8100B CPU according to Apple, the Mac mini has upgraded all it's ports to the latest specifications and includes two USB4 / Thunderbolt 3 ports which are making their debut on the new Apple M1 devices. This new USB spec uses two USB 3 lanes to offer 40Gbps transfer speeds, bringing it in line with Thunderbolt 3, but it also adds DisplayPort Alt Mode 2.0 compatibility for 8K 60Hz one-way display output at 80Gbps.

For those looking to connect the Mac mini to a more 'normie' display, it also has an HDMI 2.0 output and there's an Ethernet, two USB Type-A and a 3.5mm headphone jack to round out the streamlined interface options.

Like the other M1 devices, the Mac mini gets the same graphical performance boost, so you can expect to be playing your favourite Mac compatible games at near-1080p using moderate graphical settings.

Of course the new M1 range lines up with the release of macOS Big Sur, which Apple is calling the biggest overhaul to the OS since the introduction of macOS X. Basically Apple has rebuilt the core applications to be optimised to run on the ARM architecture. Windows did a similar thing when creating Universal Apps back in the early days of Windows 10 that would responsively open tablet/smartphone versions on smaller devices, but run full-Windows versions for machines with true PC processors. For apps not yet optimised, Apple has an AI powered script translator called Rosetta 2 that'll convert requests in real-time from x86 languages into ARM-based code. This is something that requires a little more testing to see the broad ranging compatibilities, but as far as we can tell apps that haven't been optimised seem to work as well as they did on Intel processors. While the jury's still out on this particular element, one bonus feature of the new M1 devices is that you can now run any iOS app on the new range of M1 Macs.

"When you consider that the new Mac mini range starts at $1,099 ($600 less than the i5 2018 Mac mini) we can't think of any reason why you'd choose its predecessor over the M1 variant."

The new Mac mini offers similar CPU power, significantly better graphical capabilities and updated interface options for much less than its predecessor.

★★★★★

Best result
On test

	MacBook Pro13 (M1, 2020)	Macbook mini (M1, 2020)	Macbook Air (M1, 2020)	Asus UX435	Dell XPS 13 (9310)
Score	★★★★★	★★★★★	★★★★★	★★★★½	★★★★★
Price	$2,299	$1,099	$1,949	$2,299	$2,399
CPU	Apple M1	Apple M1	Apple M1	Intel Core i7-1165G7	Intel Core i7-1165G7
Memory	8GB	8GB	8GB	16GB	16GB
GPU	Integrated (M1)	Integrated (M1)	Integrated (M1)	Nvidia GeForce MX450	Intel Iris Xe Graphics
Storage	512GB PCIe SSD	256GB PCIe SSD	512GB PCIe SSD	1TB NVMe SSD	1TB NVMe SSD
Wi-Fi	802.11ax WiFi 6	802.11ax WiFi 6	802.11ax WiFi 6	Intel WI-Fi 6 AX201	Killer Wi-Fi 6 AX1650
Screen size	13.3-inch	NA	13.3-inch	14-inch	13.4-inch
Screen type	500nit, P3, HDR, IPS	NA	400nit, P3, HDR, IPS	LCD 30 nit	
Resolution	2560x1600	NA	2560x1600	1920x1080	3840x2400
Screen finish	Gloss	NA	Gloss	Gloss	Gloss
Battery capacity Wh	58.2Wh	NA	49.9Wh	63Wh	48Wh
Dimensions (mm)	304.1x212.4x15.6mm	197x197x36mm	304.1x212.4x16.1mm	31.9x19.9x1.69mm	296x199x15mm
Thickness (cm)	1.6cm	3.6cm	1.6cm	1.69cm	1.5cm
Weight	1.4kg	1.2kg	1.29kg	1.29kg	1.27kg
Geekbench 5 Single-core (score)	1,723	1,731	1,785	1,541	1,518
Geekbench 5 Multi-core (score)	7,562	7,630	7,627	5,022	5,428
Geekbench 5 OpenCL (score)	19,700	19,784	18,394	9,008	18,093
Battery (movie playback) 1080p total playback time (H:M)	18h46min	NA	19h6min	4h51min	7h0min
Crystal DiskMark 5/6 Sequential read (Q32T1)	2,829	2,186	2,700	3,480	3,165.8
Crystal DiskMark 5/6 Sequential write (Q32T1)	2,293	2,808	2,858	2,751	3,069
Cinebench R23 - CPU	7,586	7,811	7,588	DNT	DNT
Cinebench R23 - CPU (single core)	1,517	1,521	1,494	DNT	DNT
GeekBench 4 CPU Multi core	5,758	DNT	5,784	DNT	DNT
GeekBench 4 - GPU Compute	23,273	DNT	23,234	DNT	DNT
Peak CPU temperature (°C)	DNT	DNT	DNT	95	100
Sid Meier's Civilization VI 900/1080p, Low (avg fps)	51.18	55	56	53.2	32

AMD Radeon RX 6800 XT Roundup

AMD's return to the top end of the market gets better with some cracking partner cards.

If you read our review of the reference AMD Radeon RX 6800 XT in our previous issue, you'd have seen that it puts AMD back in the race at the high end of the market, and that the 6800 XT nips at the heels of the mighty RTX 3080. Can the tried and true premium tier designs and coolers from AMD's partners beat out the surprisingly capable reference card? We take a look at some of the best AMD cards ever.

What makes them tick

Before we get to the roundup, let's revisit some of what's under the hood of the Radeon RX 6800 XT, AMD's first RDNA2 GPU. The 6800, 6800 XT and 6900 XT are all based on the 7nm Navi 21 GPU. They share the same memory subsystem, consisting of 16GB of 16Gbps memory over a 256 bit bus. The major difference between them is the clock speeds and number of compute units, with all 80 enabled for the 6900 XT, 72 for the 6800 XT and 60 for the 6800. Each CU contains 64 shader units and a single Ray Accelerator (or RT core if you adopted the Nvidia parlance).

The 6800 XT is the sweet spot card of the three. It doesn't cost too much more than the 6800 and at this end of the market a 10 or 15 percent price premium over the 6800 probably won't deter too many buyers. Once the market matures, we may see premium 6800s around the same price as an entry level 6800 XT. It will present an interesting conundrum for many buyers. The 6800 XT is quite a bit cheaper than the 6900 XT. Much like the super expensive RTX 3090, diminishing returns set in at the very top end of the market.

Advanced tech features

The 6000 series brings ray tracing to AMD's lineup for the first time. AMD is yet to introduce its DLSS competitor it calls Super Resolution, but it is working on it. Until now we've been underweighting ray tracing capabilities due to limited game support and the performance hit that comes when you enable it. But with the release of a major title like *Cyberpunk 2077* that really shows off the tech at its best, that time is over. It's now must-have tech and cannot be viewed as a bonus any longer. Ray tracing and resolution up-scaling in one form or another are going to become standard graphics features in the coming years. We're yet to see how AMD's GPUs and the next-gen consoles handle the advanced *Cyberpunk 2077* features, but there's no underselling it any longer. AMD can't fall behind. Note that AMD doesn't have an equivalent to Nvidia's Tensor cores so it will be interesting to see how AMD performs things like deep learning and AI operations.

AMD offer some interesting features including Smart Access Memory, which allows the CPU to access more or all of the GPU's memory. Some games see significant gains of 10% or more. As it's a PCIe feature, it's being enabled on Intel platforms too. Additionally, Nvidia has also announced it will add support in a future driver update. Make sure you enable the settings in your BIOS. It goes by different names and involves adjusting one or two settings. Who doesn't like free performance?

The other particularly interesting feature is something AMD calls Infinity Cache, which is essentially a level 3 cache. At 128MB it's very large. It takes up a

big chunk of the GPU area. AMD claims it reduces the need for very high memory bandwidth. This means a 256bit bus and GDDR6 is sufficient. In theory this means the cards are not overly complex hopefully resulting in lower manufacturing costs. If the availability woes go away, some nice bargains could be possible. A price war would be great for the consumer!

Availability or a lack thereof is the elephant in the room. It's terrible to put it mildly. Some reports state component shortages are to blame, or is it miners buying up container loads? The coronavirus? Perhaps it's lack of foundry capacity? At time of writing it was next to impossible buy a console off the shelf anywhere in the world so there are some serious supply issues. This means pricing is highly volatile. A recommended retail price isn't reflecting reality, and some cards are facing months of backorders. It appears that supply and price gouging issues will persist well into 2021. There would have been many disappointed gamers over Christmas.

Performance

Custom card manufacturers have their work cut out for them. In our testing the reference 6800 XT cooler proved to be a massive step forward over the noisy blower-style coolers from previous generations. It's also much better than the outwardly similar cooler of the short lived Radeon VII. It's not all about the cooler though. The custom cards tend to have more robust PCBs, support for higher power limits and overclocking and as you'd expect, loads of RGB! The other factor to consider is that the reference card probably won't be around for long. In six months any comparison to the reference card may well be moot.

Speaking of overclocks, the Asrock and Sapphire cards offer the highest GPU clocks we've ever seen at an incredible 2,360MHz, though actually they can sustain themselves even higher than that! AMD and its foundry partner TSMC really deserve credit for extracting this kind of power efficiency from a GPU without having to resort to a brute force approach. The fact that AMD is able to keep the TDP of the 6000 series to 300W is admirable. 300W isn't the limit though, as some of the partner cards will move beyond this. At least the monster coolers are capable of handling the heat, and doing it quietly, if not silently.

It's overly simplistic to assume that partner cards are all the same. You need to ask yourself: What is it that you look for in a GPU? Ask ten different people and you'll probably get ten different answers. Do you want the fastest card you can get? The quietest? The best looking one? Do you want bang for your buck? In the current climate perhaps you'll take whatever you can find in stock! Whatever your priority, one of these cards will suit you. These 6800 XTs are quite distinct from one another and one of these cards will surely impress.

Let the games begin!

CHRIS SZEWCZYK

$1,499 | www.asrock.com

Asrock Radeon RX 6800 XT Taichi X OC

A card that demands to be shown off.

There are subtle cards, silent cards and affordable cards and then there's the Asrock Taichi X. This is a card that demands to be shown off in a case with a PCie riser. It's the joint highest clocked of the tested cards and the highest performing one too.

It's got everything including a strong PCB design with dual BIOS, lashes of RGB lighting (that can be turned off via a switch) and a powerful cooler with 0db mode. At $1,499 its price is surprisingly reasonable compared to other flagship tier cards.

The Taichi X consistently topped the testing leaderboard and in some cases gets close to the 6900 XT. The Taichi was among the hotter running cards. It also gets audible under load but it's still nothing like the noisy blower cards of old. The card requires three 8-pin PCIe power connectors, which means there's some serious power on tap if you want to push it hard. Asrock rates the TDP at 300W though we think it's higher than this after measuring a peak 289W GPU power draw, the highest of the test.

Contrary to its name that suggests peace and harmony, the Taichi X is big, bright and in your face. At $1,499 it's pricey for sure, but this is a top-tier card and that price isn't out of line with other flagship 6800 XT's. Whether the cost is worth it over the likes of the Sapphire may depend on whether you want to show it off or not. As the fastest and most unmistakably premium card of the test, it's pretty hard to top the Asrock Taichi X.

SPECS Asrock Radeon RX 6800 XT Taichi X 16G OC, 1,925MHz Base Clock, 2,360MHz Boost Clock, 16GB GDDR6 16Gbps memory, 512GB/s Memory Bandwidth, 2x Display Port 1.4, 1x HDMI 2.1, 1x USB-C, 3x 8-Pin Power Connector, 300W TDP.

The Taichi X is bright, brawny and bold, and the fastest of the tested cards.

★★★★½

$1,599 | www.asus.com

Asus TUF Gaming Radeon RX 6800 XT

One for fans of silent gaming.

The Asus TUF Gaming 6800 XT is huge! Asus has many different cards in its portfolio, with the Strix and LC positioned as the performance kings whereas the TUF is clearly tuned for cool, quiet and reliable running. This is a card that you'll put into your case and happily game away at 4K, out of sight and out of mind.

The TUF is clearly positioned as a set and forget card, with a focus on reliability as its design theme. An aluminum shroud, custom PCB and even the weight of it point towards an outstanding cooling capacity. RGB is kept to a minimum.

The Asus TUF was easily the quietest card of the test. That huge triple slot cooler gave us the best temperatures too. It's got a small section that allows air to pass through to the rear of the card, a little like the Nvidia Founders Edition cards do. Is this a new way to gain maximum cooling effectiveness? With all the focus on cool running, the TUF didn't perform as well as the other tested cards but it's still ahead of the reference 6800 XT.

The Asus TUF 6800 XT is one for buyers who want a card out of sight and out of mind that performs reliably and silently without the excessive bling common to many top tier cards. It comes at a cost though. The TUF was easily the most expensive card of the test. That price is sure to drop as production stabilises. When that time comes, fans of silent gaming will find the TUF a very compelling option.

SPECS Asus TUF Gaming Radeon RX 6800 XT, 1,875MHz Base Clock, 2,310MHz Boost Clock, 16GB GDDR6 16Gbps memory, 512GB/s Memory Bandwidth, 3x Display Port 1.4, 1x HDMI 2.1, 2x 8-Pin Power Connector, 300W TDP.

The Asus TUF runs exceptionally cool and quiet, but its price is too high right now.

★★★★☆

$1,499 | www.gigabyte.com

Gigabyte Radeon RX 6800 XT Gaming OC

A card that goes about its business with no fuss.

The Gigabyte Gaming OC is one of the company's more value oriented offerings, sitting below the premium Aorus products. It's the most compact of the cards. Though it's still a triple slot card, its height makes it easier to fit into smaller cases.

The Gaming OC uses the company's Windforce 3X cooler. It's got dual BIOS and the RGB Gigabyte logo on the side is the only RGB present. It's a card that eschews bling. That alone will appeal to many users. Notably it comes with a pair of HDMI ports to go with two DisplayPorts. It's the only card in the test with this configuration.

Despite its relatively low-rated boost clock, the Gigabyte performed better than expected. It appears that this card is a strong sample in terms of the silicon lottery. A measured GPU chip power draw of 264 watts meant the card was able to consistently boost higher. In fact the card was able to maintain an average of boost clock of 2,350MHz (only behind the Asrock). The card isn't loud by any means, though it does become notably audible under a sustained load.

The Gigabyte Gaming OC is a good all-rounder, offering surprisingly strong performance to go along with a more compact and subtle design. It's not the quietest card in the test and its prerelease pricing is on the high side which hurts it. We can't put too much weight on pricing volatile market though. The Gigabyte Gaming OC will surely become a more compelling option as volume picks up and pricing settles to more representative levels.

SPECS Gigabyte Radeon RX 6800 XT Gaming OC, 1850MHz Base Clock, 2,285MHz Boost Clock, 16GB GDDR6 16Gbps memory, 512GB/s Memory Bandwidth, 2x Display Port 1.4, 2x HDMI 2.1, 2x 8-Pin Power Connector, 300W TDP.

The Gigabyte Gaming does the job of a value offering, though it needs to drop in price.

★★★★☆

$1,369 | www.sapphiretech.com

Sapphire Radeon RX 6800 XT Nitro+

The Sapphire offers a little bit of everything.

The Sapphire RX 6800 XT Nitro+ sits above the Pulse in its lineup. It makes use of a large triple slot and triple fan cooler. It too makes use of a large cutout on the rear to allow air to pass through the backplate.

The Nitro+ PCB is a high quality one, making use of a 13-phase VRM powered by dual 8-pin power connectors. Notably it's the only card in the test to omit a Type-C USB port in favor of a triple Display Ports and a single HDMI. Those triple ports alone may make the Nitro+ a favorite of triple screen users. There's also a dual BIOS. Switching to the quiet BIOS lowers the power limit by 25W which means lower clocks. There's a 3rd switch setting which enables control via Sapphire's Trixx software app. There's an RGB light bar and logo across the top of the card.

Despite its high advertised boost clock the Sapphire couldn't quite match the Asrock in performance. The differences between all the tested cards aren't significant though. The Sapphire proved to be a capable performer whilst keeping noise levels and temperatures in check. It strikes a very good balance.

The Sapphire impresses with its all-round capabilities combined with great value. At the time of writing it's one of the cheaper custom 6800 XT's despite being a premium tier card. Again though, 6000-series pricing is influenced by very low stock levels so the price on month probably won't be the price th e next and so on. We're happy to declare the Sapphire Nitro+ the pick of the bunch.

SPECS Sapphire Radeon RX 6800 XT Nitro SE+, 1,850MHz Base Clock, 2,360MHz Boost Clock, 16GB GDDR6 16Gbps memory, 512GB/s Memory Bandwidth, 2x Display Port 1.4, 1x HDMI 2.1, 1x USB Type-C; 2x 8-Pin Power Connectors, 350W TDP.

The Sapphire Nitro as a great all-rounder that's further elevated by its surprisingly good value.

★★★★★

AMD RADEON RX 6800 XT BENCHMARK RESULTS

Indicates best 6800 XT result

MIN	METRO: EXODUS		
	1920X1080 ULTRA PRESET AVG FPS	2560X1440 ULTRA PRESET AVG FPS	3840X2160 ULTRA PRESET AVG FPS
Asrock Radeon RX 6800 XT Taichi X OC	68.1	60.7	43.0
Asus TUF Gaming Radeon RX 6800 XT	68.9	59.8	41.9
Gigabyte Radeon RX 6800XT Gaming OC	69.3	59.7	42.4
Sapphire Radeon RX 6800 XT Nitro+	67.6	60.4	42.8
AMD Radeon RX 6900 XT	71.1	62.6	44.8
Nvidia GeForce RTX 3080 FE	62.6	57.4	43.9
Nvidia GeForce RTX 3070 FE	53.1	48.0	32.5

AVG	METRO: EXODUS		
	1920X1080 ULTRA PRESET AVG FPS	2560X1440 ULTRA PRESET AVG FPS	3840X2160 ULTRA PRESET AVG FPS
Asrock Radeon RX 6800 XT Taichi X OC	126.8	104.4	66.1
Asus TUF Gaming Radeon RX 6800 XT	124.7	101.2	64.3
Gigabyte Radeon RX 6800XT Gaming OC	126.5	103.0	65.0
Sapphire Radeon RX 6800 XT Nitro+	125.1	103.7	65.6
AMD Radeon RX 6900 XT	130.6	108.1	69.3
Nvidia GeForce RTX 3080 FE	130.0	105.9	68.7
Nvidia GeForce RTX 3070 FE	103.1	81.4	51.1

	GHOST RECON: BREAKPOINT		
	1920X1080 ULTIMATE PRESET	2560X1440 ULTIMATE PRESET	3840X2160 ULTIMATE PRESET
Asrock Radeon RX 6800 XT Taichi X OC	136	110	69
Asus TUF Gaming Radeon RX 6800 XT	133	110	68
Gigabyte Radeon RX 6800XT Gaming OC	135	111	69
Sapphire Radeon RX 6800 XT Nitro+	136	111	69
AMD Radeon RX 6900 XT	137	116	72
Nvidia GeForce RTX 3080 FE	122	101	69
Nvidia GeForce RTX 3070 FE	107	86	52

	MIDDLE EARTH: SHADOW OF WAR		
	1920X1080 ULTRA PRESET	2560X1440 ULTRA PRESET	3840X2160 ULTRA PRESET
Asrock Radeon RX 6800 XT Taichi X OC	200	155	95
Asus TUF Gaming Radeon RX 6800 XT	196	150	93
Gigabyte Radeon RX 6800XT Gaming OC	199	153	94
Sapphire Radeon RX 6800 XT Nitro+	199	154	95
AMD Radeon RX 6900 XT	209	162	101
Nvidia GeForce RTX 3080 FE	193	150	97
Nvidia GeForce RTX 3070 FE	161	116	71

MIN	SHADOW OF THE TOMB RAIDER		
	1920X1080 HIGHEST PRESET	2560X1440 HIGHEST PRESET	3840X2160 HIGHEST PRESET
Asrock Radeon RX 6800 XT Taichi X OC	158	118	68
Asus TUF Gaming Radeon RX 6800 XT	156	117	66
Gigabyte Radeon RX 6800XT Gaming OC	156	117	67
Sapphire Radeon RX 6800 XT Nitro+	159	116	69
AMD Radeon RX 6900 XT	167	124	71
Nvidia GeForce RTX 3080 FE	159	118	70
Nvidia GeForce RTX 3070 FE	126	94	52

AVG	SHADOW OF THE TOMB RAIDER		
	1920X1080 HIGHEST PRESET	2560X1440 HIGHEST PRESET	3840X2160 HIGHEST PRESET
Asrock Radeon RX 6800 XT Taichi X OC	194	145	79
Asus TUF Gaming Radeon RX 6800 XT	193	143	78
Gigabyte Radeon RX 6800XT Gaming OC	193	144	78
Sapphire Radeon RX 6800 XT Nitro+	195	144	79
AMD Radeon RX 6900 XT	198	152	83
Nvidia GeForce RTX 3080 FE	195	145	83
Nvidia GeForce RTX 3070 FE	160	114	62

	TOTAL WAR: WARHAMMER II		
	1920X1080 ULTRA PRESET	2560X1440 ULTRA PRESET	3840X2160 ULTRA PRESET
Asrock Radeon RX 6800 XT Taichi X OC	146.1	120.9	64.9
Asus TUF Gaming Radeon RX 6800 XT	145.8	119.1	63.2
Gigabyte Radeon RX 6800XT Gaming OC	144.4	119.0	63.5
Sapphire Radeon RX 6800 XT Nitro+	144.7	119.8	64.8
AMD Radeon RX 6900 XT	149.4	130.7	71.8
Nvidia GeForce RTX 3080 FE	155.3	126.6	76.2
Nvidia GeForce RTX 3070 FE	128.9	97.9	54.6

	TEMPS @		3DMARK	
	IDLE	LOAD	TIME SPY EXTREME	FIRE STRIKE EXTREME
Asrock Radeon RX 6800 XT Taichi X OC	39	72	8,417	22,738
Asus TUF Gaming Radeon RX 6800 XT	38	65	8,203	22,285
Gigabyte Radeon RX 6800XT Gaming OC	38	72	8,277	22,644
Sapphire Radeon RX 6800 XT Nitro+	38	74	8,384	22,690
AMD Radeon RX 6900 XT	44	78	8,570	23,558
Nvidia GeForce RTX 3080 FE	34	74	8,515	20,033
Nvidia GeForce RTX 3070 FE	32	73	6,756	16,378

$1,699 | www.amd.com

AMD Radeon RX 6900 XT

AMD's fastest ever graphics card.

Here it is, AMD's fastest ever graphics card: The Radeon RX 6900 XT. AMD claims this isn't just an RTX 3080 competitor, but a 3090 competitor too. It's a lofty claim indeed. Can it challenge for the title of the world's fastest GPU?

The 6900 XT shares a lot in common with the 6800 XT. Both share the same Navi 21 GPU, but the 6900 XT is fully unlocked with all 5,120 shaders active compared to the 4,608 of the 6800 XT. It also has 80 RT cores versus the 72 of the 6800 XT. Otherwise they both share the same cooler, 16GB memory subsystem, clock speeds and surprisingly, the same TDP at 300W. The other major difference is the price. Where the reference 6800 XT is supposed to cost $1,049, the 6900 XT goes for a whopping $1,599. Though with the current supply issues, the pricing of all high end GPUs is subject to swings and gouging.

The reference 6900 XT is powered by a robust 13-phase VRM fed by dual 8-pin PCIe connectors. You get two DP 1.4a ports, a HDMI 2.1 port and a USB Type-C port.

The 6900 XT cooler is very good. AMD has clearly put some serious effort into it. The card can get a bit on the warm side but AMD says that even 100C is within spec and our sample stayed under 80c at all times. It can be considered quiet and of course it's silent at idle with its fan stop mode. Under a prolonged load the card manages to maintain a boost clock of an incredible 2,350MHz. AMD really deserves credit for achieving such clock speeds without going too crazy on the power consumption.

When it comes to performance, and particularly performance per dollar, the 6900 XT is in a tricky position. It is faster than the RTX 3080 but not by much, and the 3080 can be had for cheaper. The 3090 is faster but it's also a lot more expensive. Which do you go for? The clincher for many may be Nvidia's advantage when it comes to ray tracing performance and super sampling. There's also availability or lack thereof. Put simply, if you're on the fence, the choice between a 6900 XT and a premium tier 3080 might come down to simple availability. Do you want a card now or can you wait for a month or two?

In summary, the 6900 XT is a very fast card indeed. AMD has made tremendous gains and it's able to beat out the mighty RTX 3080. Its weakness is its pricing. It's a very expensive card and that takes some of the shine off of it. It's some $500 more expensive than the 6800 XT for around 10% gain which doesn't really justify the extra money. Diminishing returns is a common occurrence at the top end of town. That's a shame, as a card offering genuine maximum detail 4K gaming performance in a quiet package with 16GB of VRAM is otherwise very compelling.
CHRIS SZEWCZYK

SPECS
AMD Radeon RX 6900 XT; 5,120 Shader Units; 1825MHz Base Clock, 2,250MHz Boost Clock; 16GB GDDR6 16Gbps memory, 512GB/s Memory Bandwidth; 2x Display Port 1.4, 1x HDMI 2.1, 1x USB-C; 2x 8-Pin Power Connectors, 300W TDP.

Best result
On test

	Metro: Exodus				3DMark
	2560x1440 Ultra Preset		3840x2160 Ultra Preset		Time Spy Extreme
	Min	Avg	Min	Avg	
AMD Radeon RX 6900 XT	62.8	108.1	44.8	69.3	8,570
Gigabyte GeForce RTX 3090 Gaming OC	62.2	119.3	56.4	70.5	9,517
Nvidia GeForce RTX 3080 FE	57.4	105.9	43.9	68.7	8,515
AMD Radeon RX 6800 XT	58.7	100.6	41.7	64.1	8,204

The 6900 XT beats the 3080 but the 6800 XT offers much better value.
★★★½☆

$3,799 | razer.com/au-en

Razer Book 13

Razer wants you to hit the books with its first work-focused Ultrabook.

While we've often considered the Blade Stealth 13 to be Razer's productivity-focused laptop, it's always been offered with a discrete gaming-capable GPU – which was an unnecessary expense for anyone looking exclusively for a work laptop. But Razer is finally branching out into the 'strictly business' space with the new Book 13 line, by ditching the discrete GPU and slashing the price. It's a solid move, but with Apple and Dell both offering price cuts on their Ultrabook offerings this year, the Book 13's starting price of $2,199 isn't as competitive as we'd hoped.

For that starting price you'll get a non-touch 13.4-inch 16-by-10 display at FullHD+ 60Hz, an Intel Core i5-1135G7 CPU, 16GB of RAM and a 256GB SSD, which is a couple of hundred dollars less than Dell's XPS 13, but a few hundred more than a similarly specced MacBook Air. If you want the more powerful Intel Core i7-1165G7 under the hood and touchscreen capabilities you're lookin at $2,999, while the top of the line UHD+ display will cost you $3,799. The two more expensive models aren't as competitively priced as the i5 unit, but they're not too expensive either.

The 11th generation Intel processors offer pretty standard generational performance bumps over last year's ultrabooks, so both these devices will be more than capable of tackling demanding workloads. There are still some 10th generation laptop chips that'll outperform these processors on premium gaming laptops, but the difference isn't that big and the 11th Gen chips use a lot less power.

While it might rely on an integrated GPU, the Razer Book 13 managed to snag one of Intel's Iris Xe processors on both the i5 and i7 units. As we've discussed in earlier reviews, the Iris Xe actually holds its own when it comes to gaming.

SPECS
Windows 10 64-bit; 13.4-inch touchscreen IPS display @ 3840x2400 pixel resolution; Intel Core i7-1165G7 CPU; Intel Iris Xe GPU; 16GB RAM; 512GB PCIe SSD; 55Wh battery (9h41min 1080p movie payback lifespan); 29.6 x 19.9 x 1.5cm; 1.4kg.

Indicates best result

	Razer Book 13	Dell XPS 13 late 2020 (9310)
PCMark 10 - Overall (score)	4,886	4,564
Cinebench R20 - CPU (multi-threaded)	1,860	2,053
Geekbench 5 - Multi-core (score)	5,427	5,428
3DMark Fire Strike (score)	4,876	4,498
Battery life - 1080p video playback (h:min)	09:41	07:00
Peak CPU temperature (°C)	105	100
CrystalDiskMark Read (MB/s)	3,536	3,165.8
CrystalDiskMark Write (MB/s)	2,989	3,069.1

The device is capable of getting playable (30fps+) averages on *The Division 2*, *Total War Saga: Troy*, *F1 2020*, and *Sid Meier's Civilization VI* when running at FullHD+ resolutions on low graphic settings. This powerful integrated GPU will boost productivity for anyone occasionally doing graphically intensive work and while it's not quite a gaming GPU, it's enough for those who want to occasionally play less demanding titles.

The keyboard is a little more compact than we'd like and while the keys had a good level of resistance, they are slightly too small and skew to the right. That said, it's not bad enough to be a dealbreaker and the trackpad is responsive and a nice size.

Razer has been working with Intel to get Evo (Project Athena V2) certification, which means the Book 13 will wake instantly from sleep and should get 10 hours of battery under particular conditions. In our testing we got seven hours and 40 minutes in PCMark 10's Work battery benchmark and nine hours and 41 minutes in 1080p movie playback, which is pretty good if you compare it to devices from last year. It's just hard to think of 10 hours as good battery life now that Apple's MacBooks get close to double that while outperforming anything we've seen from Intel so far in 2021.

JOEL BURGESS

A great first crack from Razer, but the Book 13 lacks bonus features to put it ahead of the competition.

★★★★☆

$6,199 | dell.com/en-au

Alienware Area 51m R2

Dell's latest gaming mothership is looking a little dated for cutting-edge extra-terrestrial gaming hardware.

Weighing in at close to 5kg with a thickness of 3.2cm, the Alienware Area 51m R2 is a gaming laptop that harkens back to the dog days of unwieldy, 'portable' gaming devices. Of course this kind of behemoth allows you to have PC-level gaming in a unit that you can actually move if you are ever required to do so, but it's not something you're going to throw in a backpack.

In addition to being unpleasant to move, the Area 51m R2 has a price tag that means you have to have an unwavering need for the most powerful device available, no matter the premium you'll pay for it. The unit we tested came in at a painfully high $6,199 price point, but while there won't be many who need this kind of device, clearly there are enough to support the ongoing rollout of mothership gaming laptops like this one.

Putting size aside,the chassis has a nice look to it with RGB highlighted black air vents and a white soft chassis coating that looks subtle, without losing the slick sci-fi-look. The full size keyboard has a good 1.7mm travel distance while the trackpad is serviceable for a machine you'd generally attach a mouse to.

You'd probably expect something higher than 1080p from a $6K laptop screen, but the Area 51m seems to prioritise high performance gaming over anything else you might want to use this device for... which means it comes with a 17.3-inch 300Hz 3ms Full HD as standard. It is a little brighter than your average display and it can reproduce 100% of the sRGB colour gamut. If you buy the device directly from Dell you'll get a faster 360Hz screen with G-Sync for $5,899 (there are no downsides we can see). You can then upgrade the display to a 60Hz 4K 500-nits display for an extra $400, if you don't need pro-level responsiveness. This higher res screen offers the wider Adobe RGB colour gamut for professional colour grading and HDR gaming applications.

SPECS
Windows 10 Home, 17.3-inch 300Hz (<3ms response) display @ 1920 x 1080 pixel resolution; Intel Core i7-10700 CPU; 32GB RAM; Nvidia GeForce RTX 2080 Super; 512GB PCIe SSD, 1TB HDD; 82Wh battery (2h4min 1080p movie playback lifespan), 40 x 32 x 3.2cm; 4.7kg.

Coming with either an Intel Core i7-10700 or a desktop Core i9-10900K (+$500) CPU you won't have any shortage of power here and while there are 11th generation laptop processors out already we'll only just start seeing updated ultra performance 11th gen laptop and desktop CPUs landing as this goes to print. The CPU is paired with 32GB or 64GB of RAM and a Nvidia GeForce RTX 2080 Super GPU as standard, so you won't have any trouble with gaming performance (or any other task) on this device. Framerates will unilaterally be over 100 fps when using 1080p ultra settings in any modern game.

As can be expected, this power hungry PC has a 82Wh Lithium-Ion battery that lasts just one hour and 33 minutes in PCMark Modern Office battery tests, so don't expect to do any on-the-go gaming. The included 512GB NVMe SSD is fast at over 3000MB/s read and write speeds, though we were a little surprised to see a hard disk drive included on the entry model, which will have a top speed of just 250MB/s.

JOEL BURGESS

Best result
On test

	Alienware Area 51m R2	MSI GS66
PCMark 10 - Overall (score)	6,989	6,702
Max CPU Temperature (C)	100	DNT
1080p movie playback (HH:MM)	02:04	03:15
HWBot x265 - 1080p (Ave fps)	57.524	50.072
3DMark Time Spy (score)	8,076	7,843
The Division 2 - 1080p Ultra (fps Av.)	107	DNT
CrystalDiskMark Read/Write (MB/s)	3,566	3,433
CrystalDiskMark Write (MB/s)	2,978	2,376

Ticks the boxes you need to be an ultimate gaming performance device, but it does so at great expense.

★★★½☆

$180 | www.dlink.com.au

D-Link DIR-1750 AC1750

A solid, low-end, last-gen router. But, who really needs much more?

It's strange to think how D-Link was top of the router game a few years ago – offering premium models that all brackets of the market found desirable. However, since Wi-Fi 6 routers started becoming mainstream (last year) the company has all but given up with the top-end of town and is flooding the budget market and lower-mid market with models to suit all possible price points at almost every increment.

The DIR-1750 is another 802.11ac (aka Wi-Fi 5) device which means it uses last-generation technology. The 1750 refers to the theoretical 1,750Mbps maximum throughput (which invariably can't be reached in real-world conditions) with the performance being spread across a single network that's automatically spread across 2.4GHz and 5GHz bands.

At $180 it's one of the cheapest routers we've tested in recent times and is one of the cheaper, branded, last-gen models you can find. We'd expect some design shortcomings at this price but we were pleased with the choices made: while the plastic housing feels cheap, its matte black chassis and four long antennae actually look quite sophisticated.

Setting it up is 'theoretically simple' thanks to an app and a QR code. Simply following all the instructions led to the LEDs shining white to show that everything was working. Unfortunately, we then encountered a bug: the app demands to know your RSP's username and password before it can move on. After multiple attempts, we had to make one up which (not surprisingly) broke the connection to our RSP and the internet LED started glowing orange. We had to fix this by accessing the browser-based firmware settings via a laptop browser as this was the only place that let us choose the automatic (DHCP) connection setup. Once we did that, everything was fine. We can't help thinking that tech novices will be knocked for six trying to figure this out for themselves, though.

The D-Link Wi-Fi app gives access to many of the minor monitoring and management settings: you can quickly see which devices are connected, initiate guest Wi-Fi, access parental controls and set up voice control via Alexa and Google Assistant – but not much else. If you want features like QoS, port forwarding and such like, you'll need to access them via a web browser.

SPECS
Speed: Dual-band AC1700Mbps | Connectivity: 4 Gigabit LAN, 1 x Gigabit WAN | Features: Parental controls, QoS, Amazon Alexa and Google Assistant compatibility.

But what of its performance? We ran our usual tests: downloading large files from a Synology DS1910+ NAS to a Dell XPS 15 OLED laptop in a three-storey Sydney townhouse. We did this up close on the ground floor, one-floor up and then two floors up. Up close it scored an impressive 529Mbps which dropped to 174Mbps and then 71Mbps as we moved up. While that's a rather steep drop, the fact that there was a solid connection at all points was impressive for such a budget router.

Ultimately, if you don't need to be streaming multiple 4K movies to multiple devices at distance, this is a very reasonable and reliable router that will suit undemanding users in reasonably sized premises. But fix the dang set-up bug, D-Link!
NICK ROSS

Loses a star for its set-up bug, but otherwise a solid, low-budget choice.
★★★★☆

From $549 | shop.westerndigital.com/en-au

WD Black D50 Game Dock NVMe SSD

A dock that'll do everything, including declutter your desk

WD has been making great strides in the portable storage space over the last couple of years, and while Seagate may have beaten it to market with a display dock that offers PCIe connected storage, the D50 Game Dock with a NVMe SSD is finally here and it's fast.

As its name suggests, the key drawcard of the new D50 Game Dock is that it comes with PCIe connected external storage allowing you to add a heap of space that is the same speed (or faster) than your primary internal hard drive. We clocked read speeds of 2,960MB/s and write speeds up to 2,319MB/s when using the D50 with a Razer Book 13 over USB-C, which is over 23 times faster than a traditional hard disk drive and five or six times quicker than an internal SSD connected over SATA 3. This doesn't make that much of a difference when dealing with small files, but it's unmistakable the second you want to move a saved movie or game files from one place to another.

The D50 Game Dock can be purchased without onboard storage for $549, or configured with either a 1TB or 2TB NVMe SSD for $825 or $1,027, respectively. This might seem steep, considering you'll have already forked out for a laptop, a screen and whatever other connected peripherals you'll want to complete your setup, but it's still cheaper than buying an additional desktop system to use at home.

If you flip to the reviews of Apple's new M1 laptops (page 26) or the Razer Book 13 featuring Intel Iris Xe integrated graphics (page 38), you'll see that extremely lightweight systems are becoming powerful enough for entry-level gaming. And if these aren't powerful enough for you then there are many gaming laptops that stand up against most desktop systems. So there's perhaps never been a better time to pool your resources to grab a system that can be used both at home and on-the-go.

The single Thunderbolt 3 input can be connected to a screen via USB-C or DisplayPort 1.4 and will expand your laptop's port options to include 2 additional USB 3.1 connections (Type-C), a Thunderbolt 3 interface, 3 USB 3.1 (Type-A) sockets, a 3.5mm audio jack and a gigabit Ethernet port. If your laptop is capable of charging via USB-C or Thunderbolt then connecting and disconnecting your power, display, networking and storage all happens through the one neat Thunderbolt 3/ USB Type-C connection.

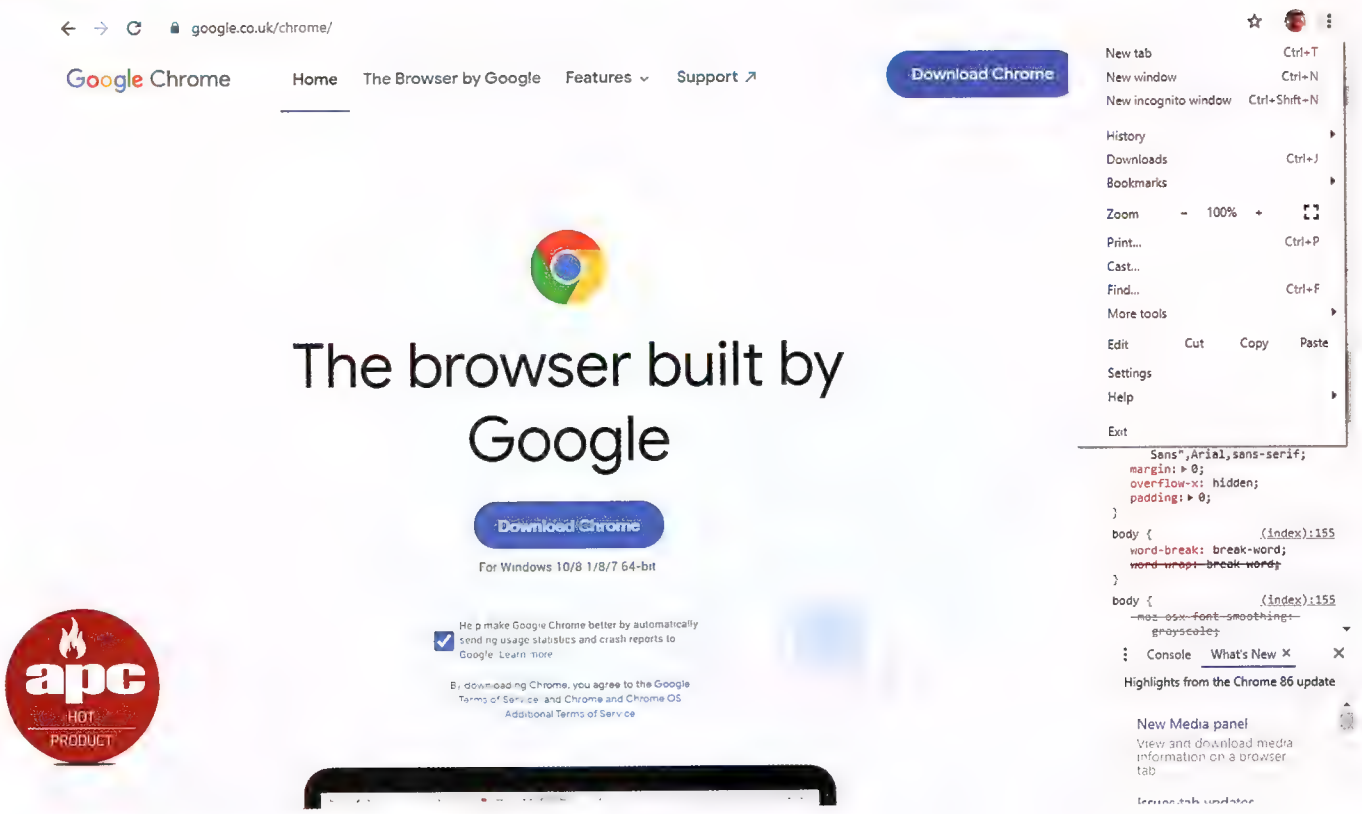
Thunderbolt 3 allows you to run a 5K external display at 60Hz, a 4K display at 120Hz or up to two 4K displays at 60Hz, so you should be able to connect to multiple gaming monitors through the one D50 laptop connection.

The device features an internal fan, which can get a little loud, but helps maintain fast SSD speeds and stable display throughput. If you're into colourful gaming tech the device also comes with Windows software that'll let you sync its base RGB strip lights with the rest of your rig.

JOEL BURGESS

A neat all-in-one display and storage dock for gamers that are willing to splurge on simplicity.

★★★★☆



apc HOT PRODUCT

WINDOWS

Chrome | Free | www.google.com/chrome **Firefox** | Free | www.mozilla.org/firefox

Google Chrome vs Mozilla Firefox

Who browses the browsers?

For the longest time everyone used Microsoft Internet Explorer, and then one day, around 2013, the world woke up and everyone was using Chrome. How did that happen, and should we care? Google launched Chrome in late 2008, when Firefox from the non-profit Mozilla was pootling along at 30 percent market share and IE at a seemingly insurmountable 70 percent share. Jump forward four years and Chrome had half the market – and increasing – with IE and Firefox fighting for second and third place.

Chrome's unstoppable success seems like a combination of agile development – quickly embracing the latest open-source technologies and standards – Google's dominant search position, its growing online tool suite, and its mobile success with Android. Google is everywhere, bringing Chrome with it.

Firefox is the sweetheart of the open-source world, the default browser in most Linux distros. It was spun out of the Mozilla Suite, which was in turn a fork of Netscape Communicator, around 2002, and has been in constant development ever since by Mozilla.

You can spot immediately that the origins of both browsers are almost diametrically opposite. Chrome being open source is largely meaningless: It's just a form of development that corporations now deem most cost-effective; it still has proprietary parts. While Google is a corporation largely funded by advertising and tracking your internet use through its browser, devices, and services, Mozilla is non-profit, funded by contributions, service subscriptions, and search-bundle deals – oddly largely with Google – and is dedicated to internet privacy and a free, open internet. Not being judgy, but Google did drop its "Don't be evil" motto too. That's not to say it's one of the bad guys, but it's something to keep in mind as it tracks your every move…

Modern browsers are complex, more akin to a mini operating system, so much so that Google launched Chrome OS built around its Chrome browser. A key element for a modern browser is parsing HTML5 correctly and quickly – we use html5test.com to test just that.

Google Chrome is super-fast, and fits in tidily with Google's ecosystem.

Chrome uses the Google-developed Blink open-source engine – a fork of Apple's Webkit – and it's in good company, with Microsoft Edge, Opera, and many others choosing to use it too. Alongside that is the Google V8 JavaScript engine. Firefox is very unusual now, as it's one of the few browsers to run its own Gecko engine and SpiderMonkey JavaScript engine. Firefox scores 464 and Chrome 476 out of 555 in the compatibility test, pitching them close for web compliance.

We should also test JavaScript and Web Assembly – a newer language envisioned to replace JavaScript – speed with a couple of benchmarks. Mozilla Kraken (**https://krakenbenchmark.mozilla.org**) returns 963ms with Chrome, and 873ms on Firefox, but it's clearly biased. There's also **https://browserbench.org/JetStream** that's built on Kraken with more tests. This put Chrome firmly ahead with a score of 113 against Firefox's 91.

We also wanted to run some direct visual tests; as we spend most of our days in a browser, optimal graphics are important. WebGL is used for 3D rendering. Our first test is from **webglsamples.org**. Chrome remained smooth at 34fps while Firefox struggled down at 13fps.

Our other visual test is **https://browserbench.org/MotionMark** that flings 2D visuals at the browser's canvas. Again Chrome's 471 appears to smash Firefox with 270 and would be in line with the WebGL test, but looking at individual test scores Firefox is as fast if not faster, bar one "multiply" test that Firefox fails.

Modern PCs have buckets of memory so its use isn't too concerning, but it's another area we can measure. Chrome used to be known as a memory hog, but it seems Google has done a lot of good work in this area. Firefox at startup uses 246MB and running JetStream this peaks at 1,462MB, while with Chrome initial start-up was 219MB, and running JetStream peaked at 1,112MB. Doing basic browsing over the same sites with the same tabs, Chrome used 802MB and Firefox 816MB.

User-friendly

Shifting our focus to usability, both Chrome and Firefox offer a similar user experience, with streamlined, minimal tabbed interfaces that can be customized with user-configured toolbars and icons. Personally we prefer the new Firefox Library that combines all browsing activity and a slicker History system. Google uses an awkward style for its Downloads and History, which seems tailored for mobile browsing. Tab management on both is excellent, able to multi-select, move, close, and restore sessions. They both have nods to accessibility, and decent zoom options and keyboard navigation.

Both browsers offer Themes and Extensions, and both recently updated the plugin systems – much to the annoyance of plugin writers. The move was to increase security but restricts access to certain APIs, though ultimately there was a compromise. Chrome being the more widely used, it has more plugins, though the quality of many is questionable. Firefox will have most of the plugins you're after but will likely miss new trends such as Netflix Party and the like.

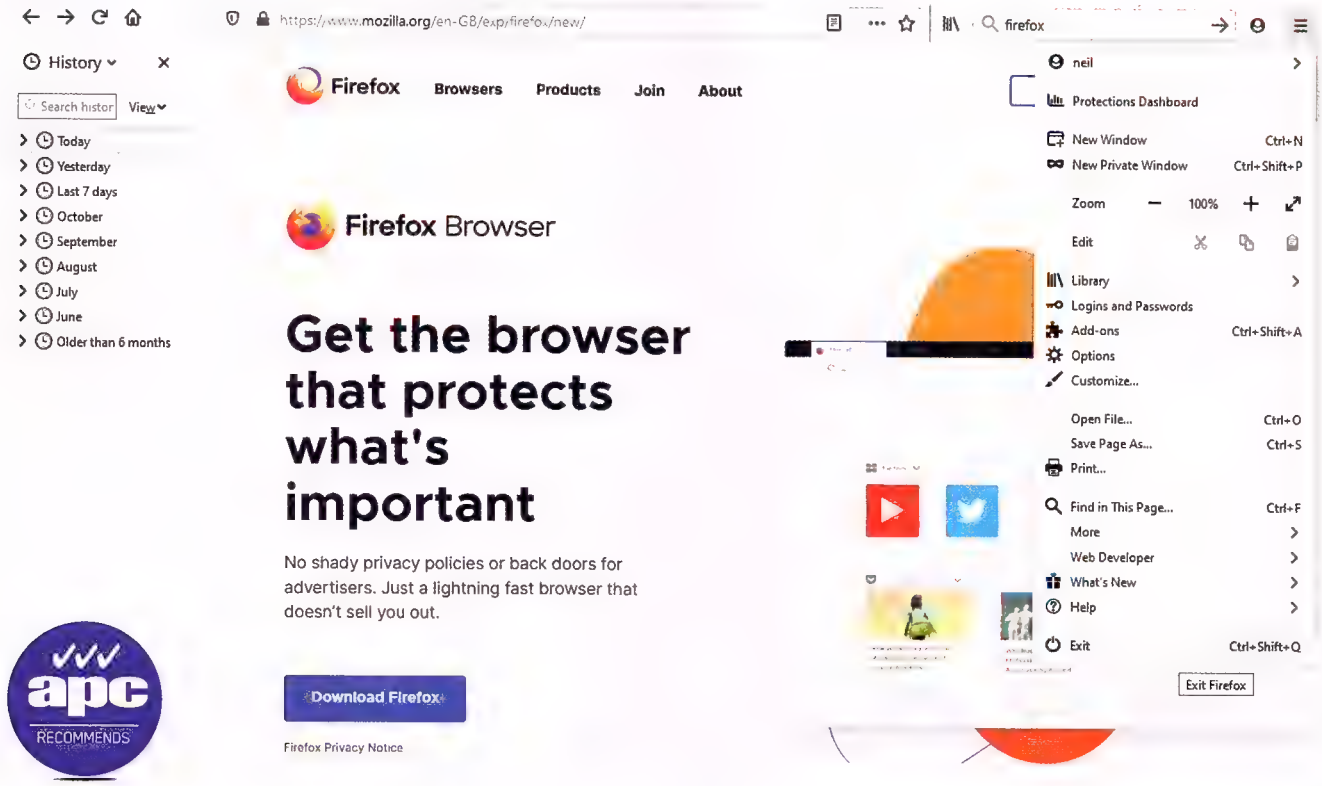
Both browsers also offer a form of roaming account and synchronisation. Your Google account will literally track everything you do and everywhere you go. Chrome has cutting-edge telemetry developed as only a world-spanning multi-billion-dollar corporation can, but it also syncs your passwords, bookmarks, and plugins. So it's all good. Mozilla's Firefox Account does all the synchronisation but without the tracking part: It's now offering a VPN privacy service, enhanced password manager, data-breach monitor, and notification service.

From a raw performance perspective it's hard to argue with Chrome: It's entirely dominant, even with memory use now. The Chromium project is used by almost all browsers outside of Apple's Safari, so it attracts huge amounts of development time, and it shows. If you use Google services then it ties your account directly to these, and its integrated services make for a seamless experience. But if you want a browsing experience free of corporate monitoring, then Firefox is a solid and dependable alternative. We also prefer its interface.

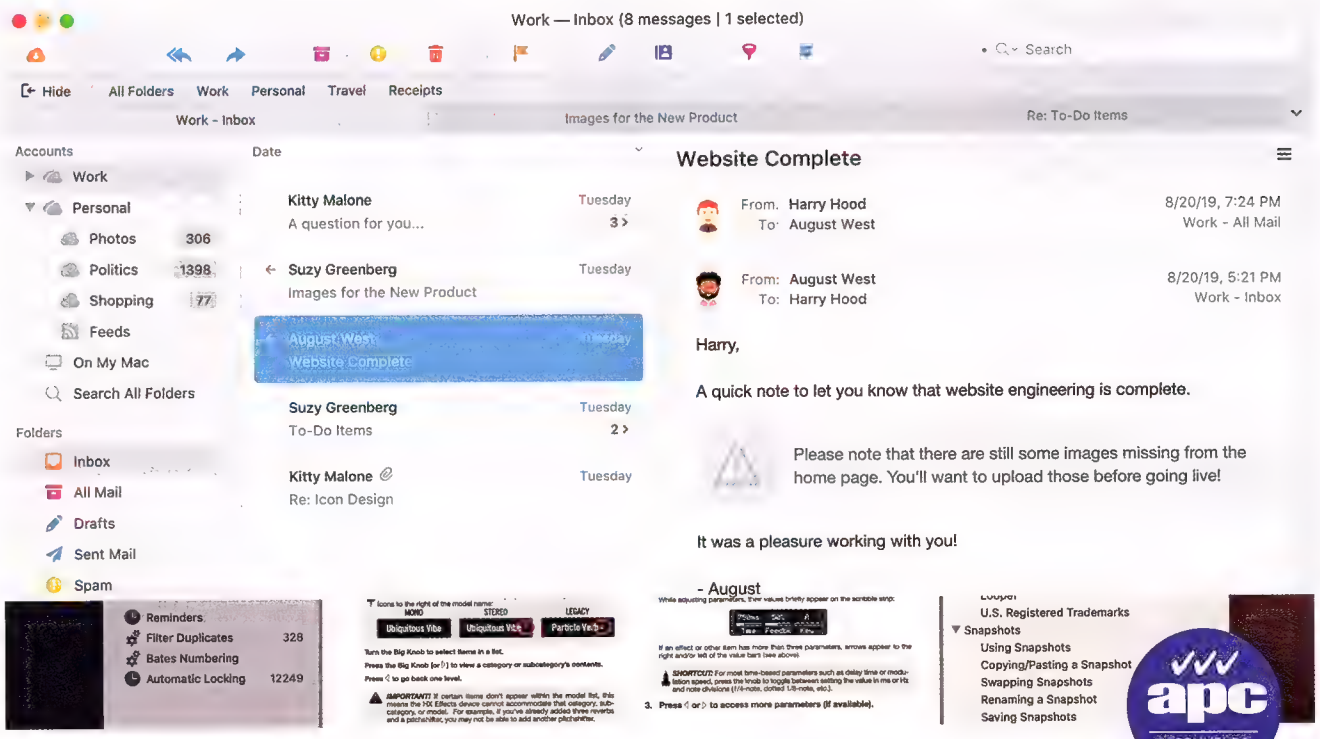
NEIL MOHR

Chrome
So fast; reasonable memory use; integrates into the Google ecosystem. Stupid history design.
★★★★½

Firefox
Mozilla has your privacy back; interesting extra VPN services; good HTML5 compliance.
★★★★☆



Mozilla has a sleek interface and has user privacy at the heart of what it does.



Needs MacOS 10.13 or later | US$29 per year | postbox-inc.com

Postbox 7

A top-class email app for your Mac.

Plenty of email apps struggle to dislodge Apple's stalwart Mail app. Can Postbox 7 do the trick? Its US$29 (about AU$39) one-year subscription – compared to the free Mail – may suggest not. Don't be fooled, though: Postbox is worth it. The app is light and airy, with generous spacing and judicious colour highlights on buttons and certain sidebar items. Apple's Mail app looks positively primitive in comparison, with its dense greyscale layout.

But looks are not everything. Fortunately, Postbox has top-notch features to overcome Apple's workhorse. Take the Focus Pane, a smart column that lets you drill down into your messages. You can select favourite contacts, frequently used tags, plus smart filters and folders, and everything else gets hidden. It's a brilliant way to cut out the distractions of an overflowing inbox.

There are other highlights, too. Mail groups email threads into conversations, but there is no indication in your inbox of what's a thread and what's a single message. In Postbox, a number next to an email shows how many threads it contains; click this number to show these messages and when they were sent. You can then quickly jump to any message in the conversation without needing to scroll.

Postbox cleverly uses keyboard shortcuts. Open a message and press V, then type a folder name to instantly move the email there. Press the S key to add a built-in reminder tag to a message, or command-up-N to create a new custom reminder, then click the Reminder button in the toolbar to view all of them.

Our only complaint is that Postbox will not automatically triage messages into newsletters or account notifications in the way Gmail and Spark do. It's a shame, and you're likely to miss this feature if you're migrating from an app that has it.

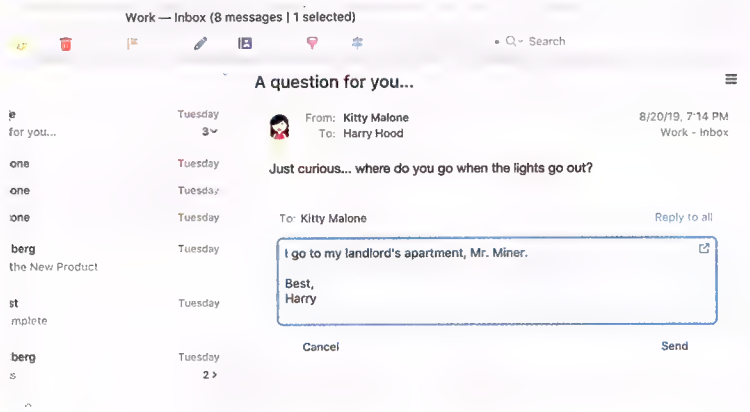
Still, using Postbox makes you realise how many of Mail's good ideas feel totally incomplete. While Mail adds flags to messages, Postbox adds topics. But Mail limits you to one flag per message; Postbox lets you add as many topics as you like, making organisation much easier. Postbox's simple tweak makes Mail feel positively ancient in comparison. With its considered ideas and modern look and feel, you'll likely feel right at home with Postbox.

ALEX BLAKE

Postbox 7 is a modern email app chock-full of thoughtful features. It puts Mail to shame.

★★★★☆

Postbox 7's layout lets everything breathe; nothing feels overly squashed together.



In a hurry? You can simply type out a quick reply to incoming mail and respond in seconds.

Free (IAPs) | punktapp.me | NEEDS iOS 13 or later

Punkt: One-Sentence Journal

A simple way to record your day.

Ever since the first cave dweller scrawled on a wall, humans have wanted to record our lives. There are now many journalling apps in the App Store, but few are as simple as Punkt.

In Punkt, you post one sentence to describe your day. You can tag it with a mood and assign it to a category so, for example, you might have felt awesome because you were with friends. You can link the entry to a Maps location, and if you're a subscriber you can add photos. Subscribing also enables you to edit your posts and make more than one post per day. The app can remind you to post each day and can also put an inspirational quote in your notifications.

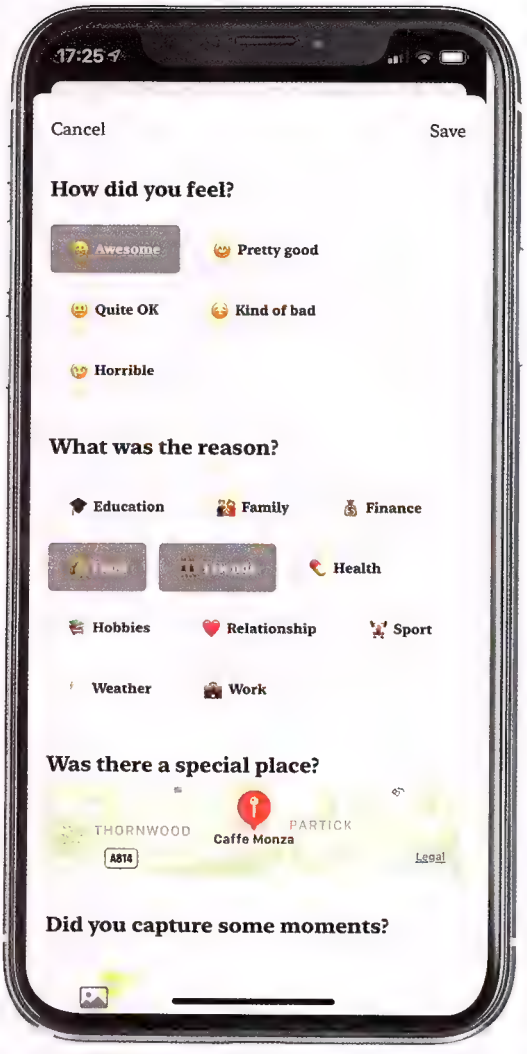
As you'd expect, tags and locations enable you to revisit content – so you can see your 'happy places', as the app calls them, or revisit your 'good times'. Tapping on a specific tag will show you the journal entries for that tag. It works well but there aren't many tags – five moods and eight categories – and you can't create your own. So, for example, you can't tag the concerts you go to as a separate category or have different tags for different groups of people: if you want to tag something you've done with somebody else the only available tags are family, friends, relationship, or work.

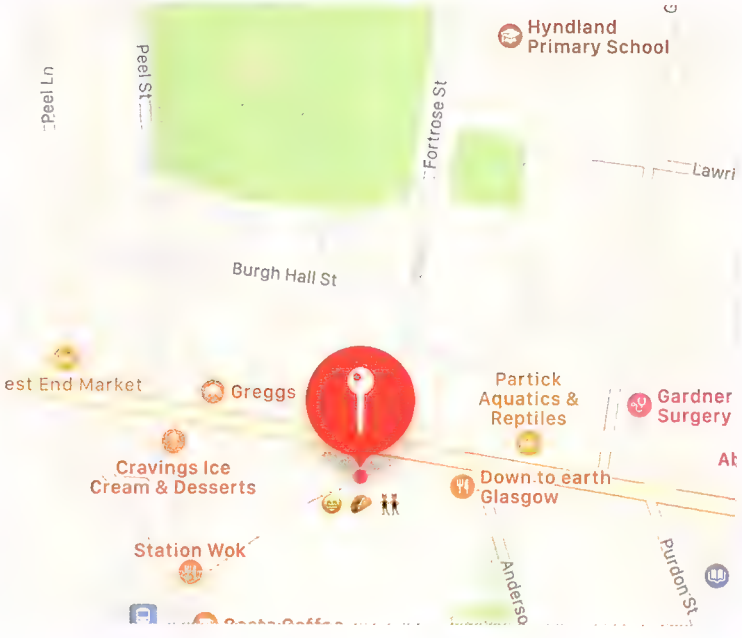
In addition to your journal entries, Punkt also enables you to see statistics: how many words you've posted, how many consecutive days you've posted, and how frequently you've used specific mood tags. If you used the most cheerful tag on Monday but a less cheerful one on Tuesday, you'll see a graph portraying your mood dipping. Underneath the graph you'll then see the influences on your week, which gives you a percentage breakdown of the categories you've tagged your post with. If half of your posts are tagged Friends and half Food, it'll tell you that your week was 50 percent influenced by friends and 50 percent influenced by food. We're not sure that's an actionable insight, but your mileage may vary.

Punkt is attractive, secure (protect it with Touch ID or Face ID), and easy. But its simplicity may be its weak point – a lack of customisable tags means it may be too limited for some.
CARRIE MARSHALL

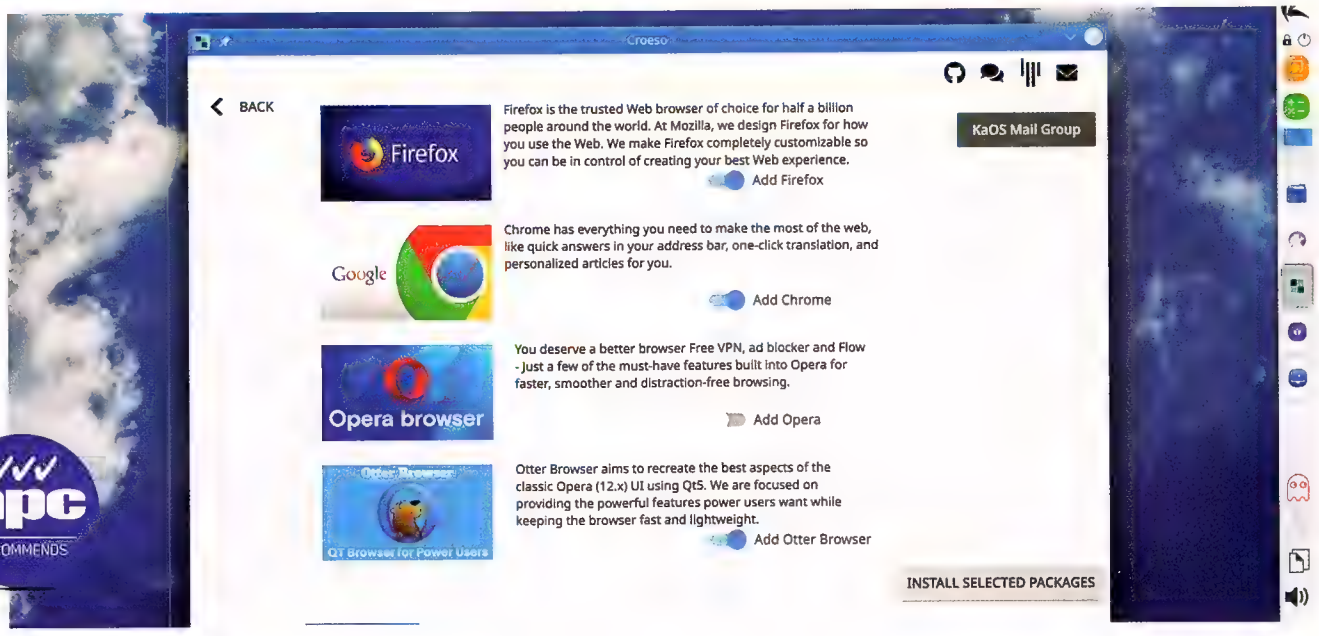
Simple, attractive, and fun – but lacking some tagging options.
★★★☆☆

Punkt asks you to sum up your day in a sentence, using a limited number of tags to show how you felt.





With Punkt you can also tag your posts with locations.


Croeso
BACK
Firefox
Firefox is the trusted Web browser of choice for half a billion people around the world. At Mozilla, we design Firefox for how you use the Web. We make Firefox completely customizable so you can be in control of creating your best Web experience.
Add Firefox
KaOS Mail Group
Google
Chrome has everything you need to make the most of the web, like quick answers in your address bar, one-click translation, and personalized articles for you.
Add Chrome
Opera browser
You deserve a better browser Free VPN, ad blocker and Flow - just a few of the must-have features built into Opera for faster, smoother and distraction-free browsing.
Add Opera
Otter Browser
QT Browser for Power Users
Otter Browser aims to recreate the best aspects of the classic Opera (12.x) UI using Qt5. We are focused on providing the powerful features power users want while keeping the browser fast and lightweight.
Add Otter Browser
INSTALL SELECTED PACKAGES
apc
RECOMMENDS

Linux | www.kaosx.us

KaOS 2020.09

Because he lacks the time, patience and, frankly, the skills to install Arch, Mayank Sharma is always looking for options that will make the task easier.

First things first: KaOS doesn't identify itself as an Arch-based distro. The project reasons that it borrows aspects not just from Arch but also from various other projects, and identifying it with one would be wrong. KaOS instead calls labels itself as a built-from-scratch distro since all packages in each of its repositories are compiled by the project for the distro.

The real difference between the two is that unlike Arch, KaOS isn't afraid to make choices on behalf of its users. The distro targets KDE users who prefer quality over quantity and are happy with a limited set of quality tools for a particular purpose rather than a collection of them. KaOS' approach to putting together a distro is the antithesis of Arch.

KaOS is what we call a semi-rolling release; you can keep updating your installation without ever re-installing, but not all of its repositories roll over as fast as some of their peers. The Apps repository is fully rolling, unless a program needs to be built using libraries or components in the Core and Main repositories. In this case, the applications will be held back until the other components get the green light. The Core repository is rolled carefully only after thorough testing, because it contains packages that are essential to the stability and performance of the installation. On the other hand, many of the packages in the Main repository, which is made up of essential libraries and drivers, are rolled over after about a week of testing.

Another distinguishing aspect of the distro is how it rolls the two versions of the kernels it supports. All new major kernel releases are tested for at least six weeks as the linux-next kernel. When the amount of upstream activity on the release slows down and the developers deem it to be stable enough, the linux-next kernel is pushed as the new stable KaOS kernel.

KaOS also makes regular ISO releases for users to jump into the bandwagon without being confronted by a humongous first update. The September 2020 release is the latest of these snapshots that brings with it updated apps and several new changes.

In terms of desktop experience, KaOS uses the Calamares installer and forces the use of XFS as the default filesystem. Once installed, the Croeso (Welsh for "welcome") tool greets you and provides shortcuts to documentation and offers to adjust some 15 commonly used settings. It's one of the most complete greeters that can help you set up and configure all the important aspects of the installation.

KaOS has tweaked several aspects of the Calamares installer, such as using a real-world map in the Locale module, which has also been accepted upstream.

MINIMUM SPECS

CPU: Any modern 64-bit, Mem: 2GB (4GB for a usable experience), HDD: 8GB as absolute minimal (25GB recommended), Build: 64-bit only.

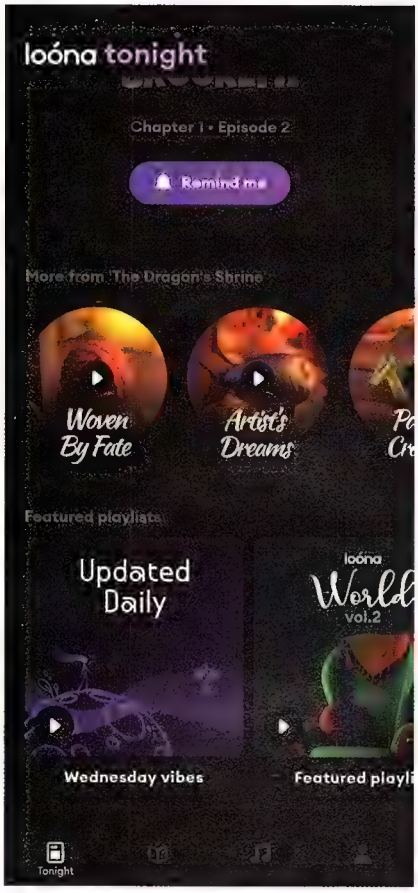
The one aspect that's KaOS through and through is the placement of the application launcher on the right-hand side of the screen. We tried to get used to it, but were unable to. Thankfully, it can be easily relocated.

In terms of programs, KaOS has the usual set barring a few exceptions. The one major victim of the distros bias for everything KDE/Qt is the web browser, with KaOS shipping with the Qt-based Falcon. That said, it does offer several non-Qt tools in its mirrors (where the Qt equivalent isn't up to the mark) and you can pull in the usual mainstream ones either using Croeso or from Octopi, the graphical front-end to the pacman package management system.

In addition to the official sources, the distro also has a community-maintained repository called KCP that includes a lot more non-Qt tools. If you don't share KaOS' fetish for Qt, you can browse KCP's list of packages from the browser and install them by copy-pasting a single command, thanks to KCP's integration with the distro's package management system.

A refined KDE distros that's stabilised the rolling release model enough to create a functional desktop distro out of it.

★★★★☆



ANDROID/IOS

Loóna: Bedtime Calm & Relax

Warm milk.

Free/Subscriptions

The app to take out Google's top pick this year was the relaxation assistant Loóna: Bedtime Calm & Relax. This app is all about getting you ready for sleep and users seem to report having a better time of it after a week or so of use. Loóna provides a bunch of different options to help with this, which is good because you might find your mileage varies. The sleepscapes, for example, are 3D models you gradually tap to fill with colour as per the instructions from a soft calm voice. I think they're meant to be a calming simple task to get you in the headspace to sleep. However, for me these are actually tedious and frustrating, rather than relaxing. But there are other soundscapes and stories which were much more up my alley. With all the different helpful tools, I can see why Loóna got Google's top pick. It's a good idea to try every aspect before committing to dropping money to make sure it's for you.

★★★☆☆

Android/iOS

Calmaria

Breath in AND out.

Free

Another award winning app is the breathing instructor Calmaria. I think it says a lot about 2020 that an app whose sole function is to instruct you in simple meditative breathing is a big winner. Calmaria is very simple. Literally all it does is count and tell you when to breathe in, hold it, and breathe back out. This isn't necessarily a criticism. Breathing exercises are wonderful to help with stressful moments and being able to load up an app that instantly takes you to them is great. You don't have to worry about making choices, or completing other tasks. Just open the app, follow the instructions, and breathe. There's no sound, which avoids any weird or jarring noises, and instead uses small vibrations which can be turned off to let you know when to change gears. It'd be nice to have some options to customise times and reps to better suit an individual's needs, but otherwise it's a solid, simple design.

★★★★☆

Android/iOS

Tayasui Sketches

Water colours.

Free/$9.99

Tayasui Sketches was listed in Google's Best Hidden Gems category and as it's a drawing app, I had to check it out. The free app is pretty damn limited, and almost feels more like a demo to check it out before you buy. You don't get layers and many of the brushes are locked behind the $9.99 paywall. So I think it's best to think of the free app as a trial, rather than something that's particularly good value. The good news is it does let you test out Tayasui Sketches' best feature to some extent. This app has been designed to mimic brushes in a somewhat realistic way, and it does a pretty good job with watercolours. There's even a button you can push to choose when the paint dries. In real life, water colours are great for creating quick beautiful art, and I feel Tayasui Sketches does a reasonably good job of recreating this experience. The biggest downside is I'm still finding the UI a little confusing, but most drawing apps take some learning to familiarise with new layouts.

HOPE CORRIGAN

★★★☆☆

FEATURE

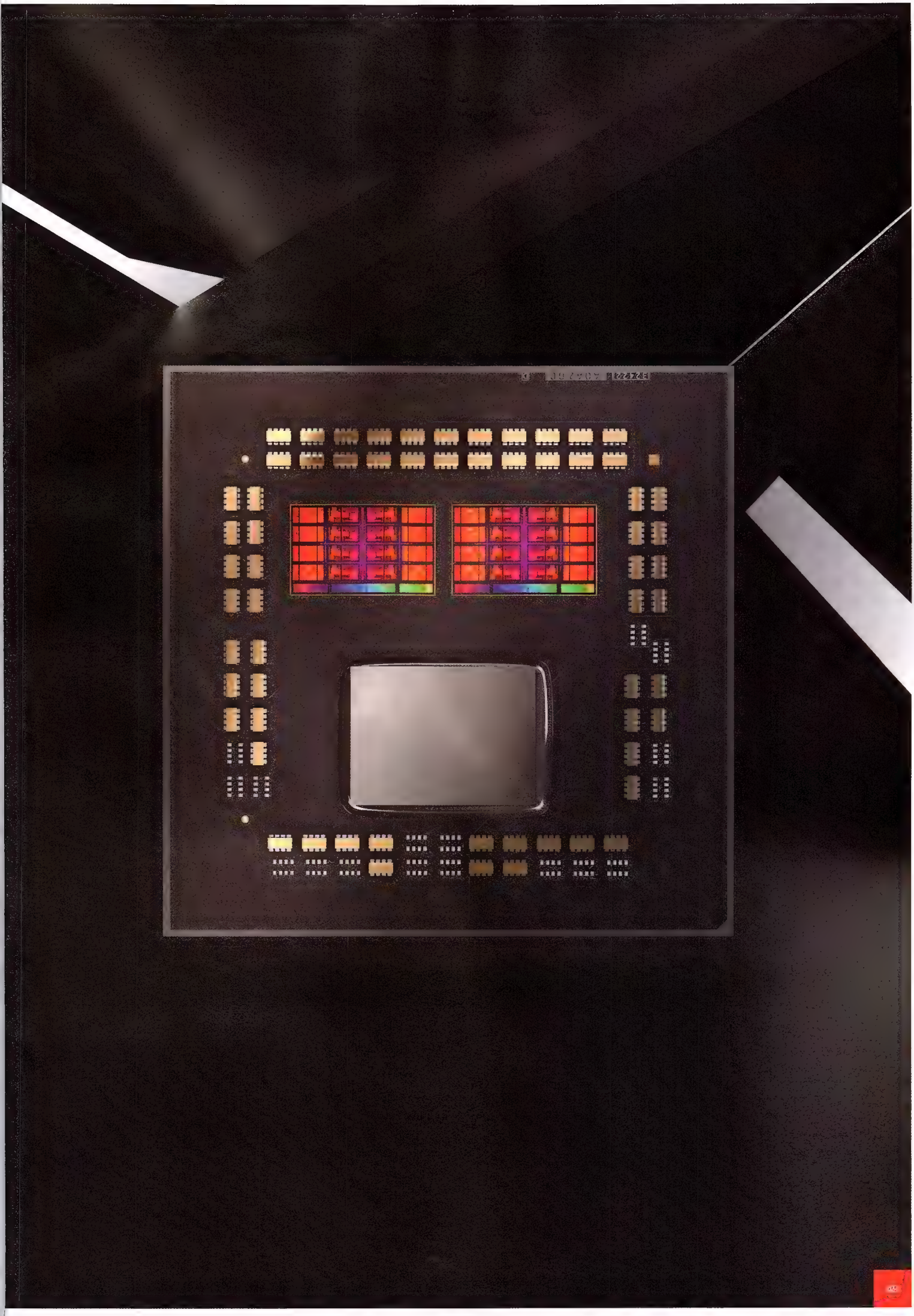
AMD ZEN3 UNWRAPPED

The Ryzen 5000 CPUs significantly improve on an already successful 7nm design. Jarrod Walton deep dives.

2020 certainly was an intriguing year. Whether that's the global climate, the COVID pandemic, or computing, as ever nothing stays the same. The only thing that's seemingly permanent is impermanence. There's nowhere else that this premise can be better observed than in the realm of processing power. From the advent of Nvidia's RTX 3000 series, to AMD's RDNA 2 graphics cards launching, 2020 has seen some revolutionary leaps in performance.

But that's not what we're talking about here today. It's all about the processors, and namely AMD's latest Zen 3 or 5000 series chips. Take a moment just think back 10 years – how far we've come in this last decade has been remarkable. The potency of the humble desktop has increased exponentially. Moore's law may be coming to an end as far as transistor density and performance is concerned, but as always, thanks to human ingenuity, we're seeing more brilliant minds pivot themselves, to push processors further and harder than ever before. Long gone are the days of 10 percent performance increases year on year, that's for sure.

Since the launch of its first Zen architecture back in 2017, AMD has shown time and time again, with each generational advancement of its processors, that it's got more than enough clout to take on Intel on the grand stage of CPU dominance. And with this latest 3rd-generation architecture, it's aiming its sights squarely on Intel's IPC crown. Are we about to see a revolution in the way modern-day computational processing progress is led? How exactly has AMD managed to sneak in and steal the crown from the giant that is Intel? And is AMD's 7nm Zen 3 architecture that radically different to its previous iteration? What makes it all tick? Well if you're interested in that, dear reader, it's time to turn the page and find out what the future holds for all of us.



Architectural advantages

AMD's CPU team is firing on all cylinders, making Intel's 14nm designs like Comet Lake look increasingly outdated. AMD's Ryzen 9 3950X was already making short work of Intel CPUs in just about every discipline – except gaming. Zen 3, also called Vermeer, aims to take on Intel in its last refuge, and the architectural changes required to do so aren't even that significant. Like Zen 2, Zen 3 uses TSMC's 7nm N7 process for the CPU chiplets, and 12nm FinFET for the IO chiplet. However, a few smart adjustments are set to make a big difference.

Putting things into perspective, Intel now has SuperFin, the marketing name for its third generation 10nm lithography that's already used in the new Tiger Lake CPUs. But Tiger Lake is mobile-only and currently tops out at four-core/eight-thread designs, and it will be a while before up to eight-core/16-thread chips launch. Intel also has Rocket Lake coming in Q1 of 2021, which will still use 14nm lithography, but with a new architecture – the first truly new desktop architecture from Intel in over five years!

At a high level, AMD says the new Zen 3 CPUs boost IPC (Instructions Per Cycle) by 19 percent across a broad suite of test applications. That might not seem like much when new GPUs come out that improve performance by 30-50 percent, but IPC affects everything. What's more, AMD says that these IPC gains will be realised without having to change power targets relative to Zen 2, which means the top chips will still have a 105W TDP.

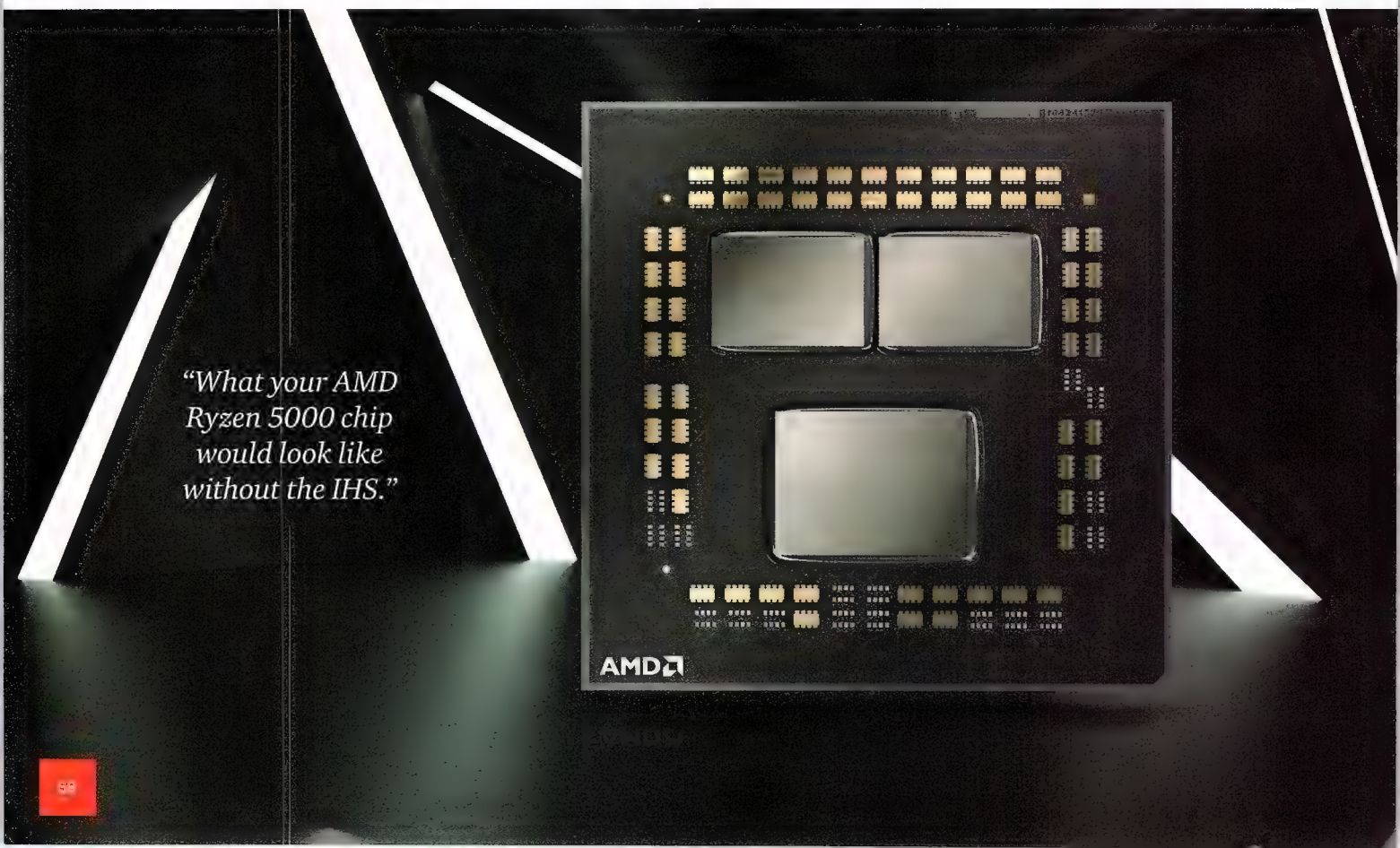
You can see the full rundown of AMD's Ryzen 5000-series CPUs in the table on page 55. AMD will initially launch with four models, replacing the most popular Zen 2 CPUs in its lineup. All of these new CPUs will drop into existing X570 and B550 motherboards after a BIOS update. At the top is the Ryzen 9 5950X, a 16-core/32-thread behemoth that can boost up to 4.9GHz – that's 200MHz higher than the 3950X. The base clock is technically 100MHz lower, but it's doubtful that it will matter, as the chips are almost certainly going to run in the 4.3-4.5GHz range even under full load. That same pattern of slightly higher clocks with the same core and thread counts continues down through the 12-core, eight-core, and six-core models.

Looking at the specs sheet doesn't tell the full story, however. The biggest change is the new unified L3 cache. Previously, AMD CPUs used two CCX blocks of four cores each, with an attached 8MB (Zen, Zen+) or 16MB (Zen 2) L3 cache per CCX. With Zen 3, the CCX becomes a native eight-core block with an attached 32MB L3 cache. To understand why this matters, we need to review some of the basics of how moderns CPUs work.

Understanding the memory hierarchy

All of our computing infrastructure, from tiny chips in smartphones up to massive supercomputer installations, works on a principle of tiered data. With modern applications potentially using gigabytes and even terabytes of data, the difficult problem is figuring out how to best organise access to all of that data. The solution that's used is known as the memory hierarchy, ranging from tiny amounts of capacity with effectively instantaneous access, up to massive storage clusters that can hold petabytes of data but may require seconds per access, and everything in between.

The fastest storage solutions are in the CPU registers, which are part of the ALUs (Arithmetic Logic Units) that do the actual calculations. There's no delay for a



"What your AMD Ryzen 5000 chip would look like without the IHS."

"AMD's Ryzen 3000-series processors were the first to house the Zen 2 architecture, despite the confusing name."

CPU working on data stored in a register, but the total number of registers is extremely limited. Without getting too deep into the technical details, there are only eight general-purpose registers exposed to software in modern x86 CPUs, with 16 MMX/SSE/FP registers and up to 32 AVX registers – the latter being used for various vector math functions. Each register is anywhere from 64 bits to as many as 512 bits in size. That works out to a maximum of 2KB of total register space for AVX-512 instructions, for example.

Thanks to a core-complex redesign, Zen 3 can now connect 32MB of cache to eight cores, reducing access latency times significantly.

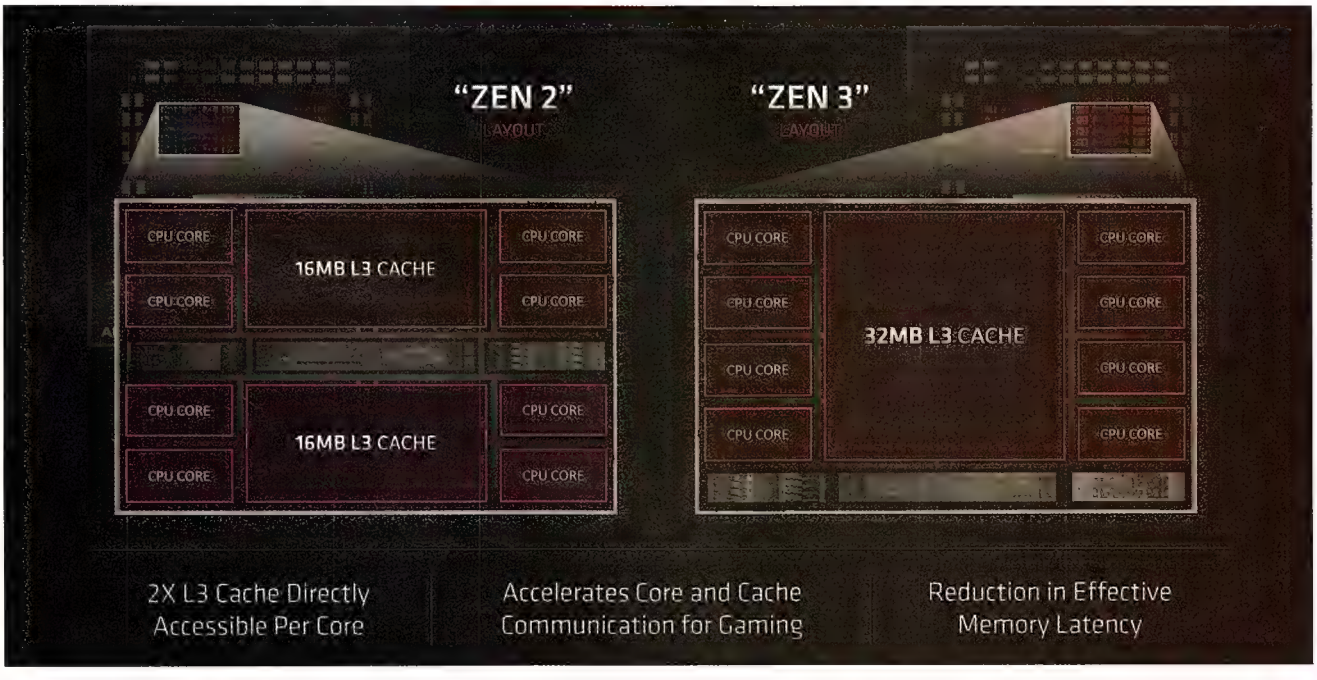
Because register space is so limited, software ends up spending a lot of time storing existing values from registers and loading new values into registers. It's a constant juggling act, and often data will be kicked out of one register only to be needed a few dozen instructions later. That can be incredibly inefficient, and the solution is to add cache. CPUs typically have at least three levels of cache these days, each succeeding level being larger but slower than the lower-level cache.

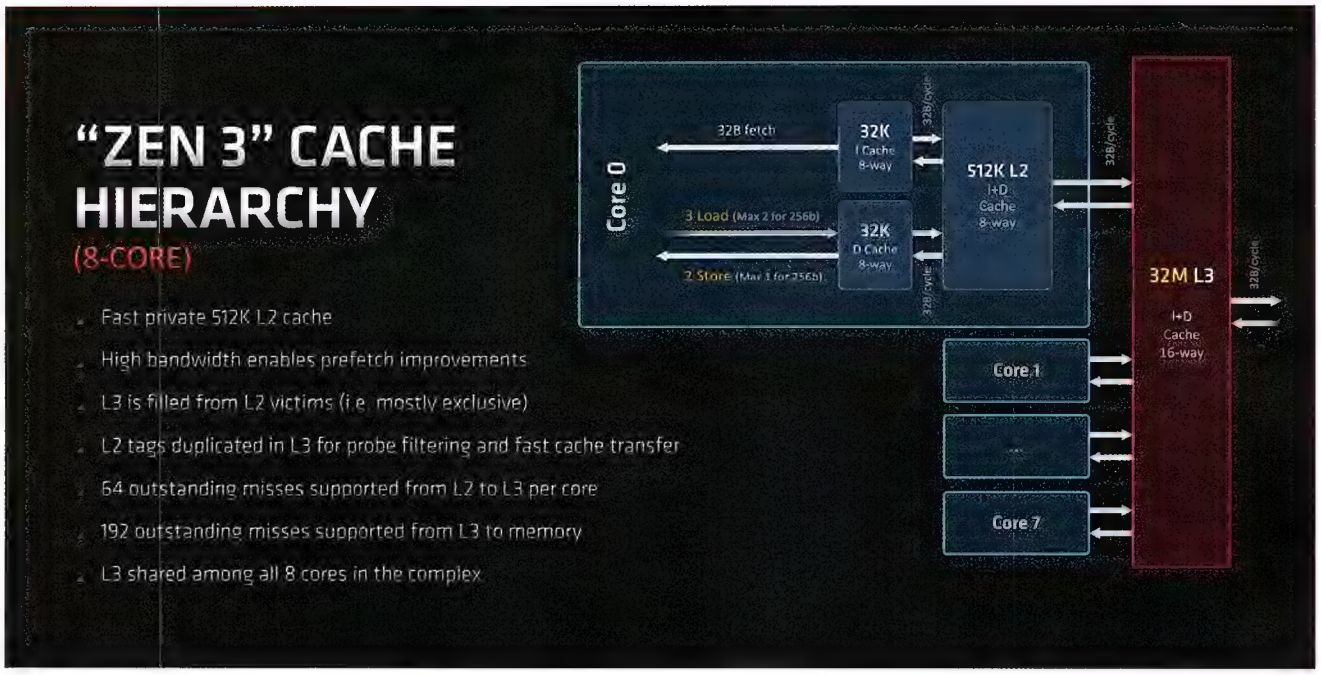
Note that internal register renaming allows a CPU core to have more actual registers, but there are still normally only a few hundred total registers. Some architectures may even refer to the renamed registers as an L0 cache, but either way it's data that can be accessed with no delay penalty.

For example, L1 cache is often 64KB to 96KB in total capacity. Each line of the cache holds 64 bytes of data, the idea being locality of reference: If you access data stored at memory address 0x0100 as an example, the code is more likely to also access data at 0x0108, 0x0120, and so on, in the near future. L1 cache sizes are larger than the registers, and access speed is usually around 1ns, give or take. That translates to anywhere from four to eight cycles, but because the CPU is aware of data accesses in advance, it's often able to pre-load data from the L1 cache into a register before it's needed. Basically, L1 cache is nearly instant access.

Because L1 cache is so fast, it also needs to be small, and most architectures split the L1 into a data cache and an instruction cache. Zen 2, for example, has a 32KB L1 data cache and a 32KB L1 instruction cache. Intel's Skylake and its derivatives also had a 32K+32K L1D and L1I cache size, while more recent architectures like Ice Lake and Tiger Lake have a 32K L1I cache and a 48K L1D cache size.

L2 cache is another big jump in capacity, and it's no longer split




"ZEN 3" CACHE HIERARCHY
(8-CORE)
Fast private 512K L2 cache
High bandwidth enables prefetch improvements
L3 is filled from L2 victims (i.e. mostly exclusive)
L2 tags duplicated in L3 for probe filtering and fast cache transfer
64 outstanding misses supported from L2 to L3 per core
192 outstanding misses supported from L3 to memory
L3 shared among all 8 cores in the complex
Core 0
32B fetch
32K I Cache 8-way
32B/cycle
3 Load (Max 2 for 256b)
2 Store (Max 1 for 256b)
32K D Cache 8-way
512K L2 I+D Cache 8-way
32M L3
I+D Cache 16-way
Core 1
Core 7

into separate data and instruction caches. AMD's Zen 2 and Zen 3 architectures stick with the same 512KB per core, while Intel's Skylake and derivatives have a 256KB L2 cache size – but the newer Ice Lake chips have 512KB L2 cache, and Tiger Lake is up to 1.25MB L2 cache per core. Intel's HEDT Skylake-X and derivatives had a 1MB per core L1 cache. Access latency on L2 cache is around 12 cycles, give or take, depending on the architecture. Some of the larger L2 caches may have slightly higher latencies as well, as there's a balancing act between size and latency (and set associativity, but that's another topic).

Finally, L3 cache ranges from about 2MB on the lowest tier modern CPUs (i.e. Intel Celeron) up to sizes as large as 64MB on consumer chips – the top Threadripper models even have as much as 256MB of L3 cache! Unlike the L2 and L1 caches, L3 cache is shared among all of the CPU cores. That means data accessed by core one and then subsequently needed by core eight could be in the L3 cache. With the large increase in capacity comes a similar increase in latency, and the Zen 2 architecture has about a 40-cycle latency for its L3 cache. Except when it doesn't, which we'll get to in just a second.

The whole idea of cache memory is to reduce access latencies on data that the CPU needs. A modern CPU running at 4GHz does four cycles every nanosecond. L1 cache may have an access time of less than 1ns, L2 is 3-4ns, and L3 is around 10-15ns (maybe more, depending on the architecture). But as bad as that sounds, it's nothing compared to system memory. Even though fast DDR4-3200 CL14 may have a theoretical latency of 8-10ns, real-use latency is more like 60-80ns, sometimes more. That means the CPU can get stuck waiting for 250-400 cycles when pulling data from system RAM. And that's still nothing compared to SSD or HDD storage, which can cause thousands of cycles of delay.

In short, the cache hierarchy is critical to realising the performance potential of modern CPUs. Improving the caches is thus one of the main ways of increasing CPU efficiency.

Reworking the L3 cache for Zen 3

The biggest change with Zen 3 is that AMD has overhauled its L3 cache. Actually, it overhauled the whole CCX (Core Complex), which is the fundamental building block for AMD's Ryzen CPUs. Let's quickly talk about how Zen 2 and earlier Ryzen CPUs worked, and then we'll move on to how exactly Zen 3 improves things.

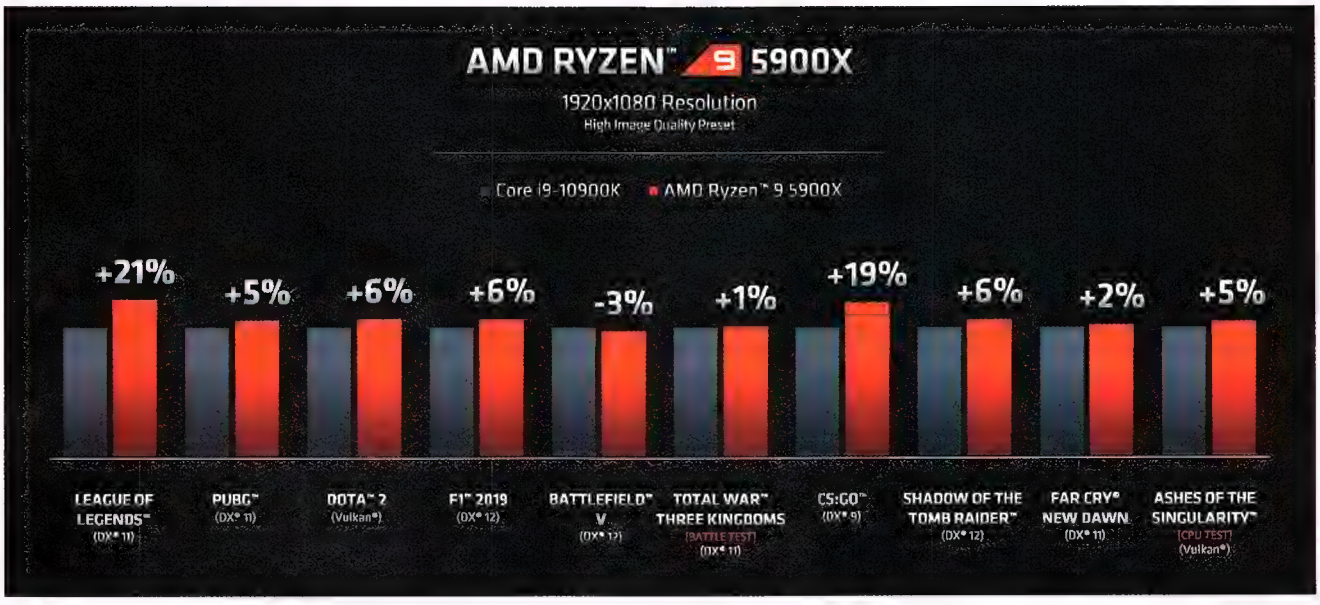
Each CPU chip or chiplet in the previous-generation Ryzen CPUs contained two four-core CCX blocks. The L3 cache was directly tied to the CCX, and while it was shared between all of the CPUs, access latencies weren't consistent. The cores in a CCX directly attached to the L3 for that CCX had a latency advantage. Cores in a different CCX had to route requests for data over the Infinity Fabric.

A reduction in latency like this will dramatically improve IPC performance, ideal for gaining that edge in gaming, and single core tasks.

As an example, cores one to four on a Ryzen 9 3950X are in one CCX on the first chiplet, cores five to eight are in the second CCX on the same chiplet, cores nine to 12 are in CCX1 on the second chiplet, and finally cores 13-16 are in CCX2 on chiplet two. That's four groups of four CPU cores, and four 8MB L3 cache blocks.

Here's where things get difficult. Every L2 cache miss checks the four L3 caches to see if they contain the desired data. If the local L3 has a hit, though, things are much better than if the data is in one of the other L3 caches. That's because on Zen 2, the L3 cache access ends up going from the requesting core over the Infinity Fabric to the cIO chiplet, then to the CCX that has the data in its L3 cache, and then back over to the cIO chiplet before it ends up at the requesting CCX. Even on Ryzen 7 3700X, which only has a single CPU chiplet and the cIO chiplet, L3 cache requests from CCX1 to CCX2 are routed that way.

It's messy and slow, and the solution is to move away from a four-core CCX with attached 16MB L3, to an eight-core CCX with an attached 32MB L3. That's basically the biggest change with Zen 3



compared to Zen 2. Even though the larger L3 may be slightly slower, overall cache latencies should be much lower. There are two reasons for this. First, in single-compute chiplet Zen processors (e.g. the eight-core 5800X and six-core 5600X), there won't be any L3-to-cIO chiplet traffic to worry about. Second, even on the dual-compute chiplet processors, there won't be any Infinity Fabric traffic for L3 requests from the same compute chiplet; it's only L3 accesses from one compute chiplet to the other that route over the Infinity Fabric. That's a net reduction in traffic, and a reduction in latency.

Comparing AMD's Ryzen 9 5900X 12 core to Intel's Core i9-10900K sees significant improvement in almost every single title at 1080p.

Other changes and non-changes for Ryzen 5000

Interestingly, there are a lot of things that AMD isn't changing for the Zen 3 and Ryzen 5000. For starters, there won't be a new chipset. Existing X570 and B550 boards should have updated firmware in place to support the new CPUs, though some new board designs will inevitably arrive specifically built for Zen 3. AMD previously said it wouldn't support Ryzen-5000 CPUs on earlier AM4 chipsets and motherboards, but community feedback prompted a change of heart. X470 and B450 boards will now get updated firmware for Zen 3, with some limitations. The boards still won't support PCIe Gen4, but there are other caveats.

First, the new firmware will drop support for older AMD CPUs. Right now, an X470 board can run Zen, Zen+, and Zen 2 CPUs and APUs. After flashing the BIOS, the board will only support Zen 3. Second, the flash will be one direction only for some reason, and AMD says it will require confirmation that a user has purchased a Zen 3 CPU before allowing the BIOS download. We're not quite sure how that's going to work, as it may be as simple as a message saying, "Please click to confirm you understand your board will no longer support Ryzen 3000 and earlier CPUs after flashing." Finally, the beta firmware updates for X470 and B450 won't begin arriving until January 2021.

Other things that remain the same include the cIO chiplet. It's still manufactured on GlobalFoundries' 12nm process. Considering the demand for TSMC's N7 node, this is a smart move. Nvidia likely couldn't come to an agreement with TSMC for enough N7 wafers to build its RTX 30-series GPUs there, opting instead for Samsung. The current cIO die has everything else that's needed, and apparently any power savings available by moving to

AMD Zen 3 Ryzen 5000-Series CPUs

	RYZEN 9 5950X	RYZEN 9 5900X	RYZEN 7 5800X	RYZEN 5 5600X
CORES/THREADS	16 / 32	12 / 24	8 / 16	6 / 12
BASE/BOOST FREQUENCY	3.4 GHZ / 4.9 GHZ	3.7 GHZ / 4.8 GHZ	3.8 GHZ / 4.7 GHZ	3.7 GHZ / 4.6 GHZ
TDP	105W	105W	105W	65W
L3 CACHE	64MB (2X32)	64MB (2X32)	32MB (1X32)	32MB (1X32)
PRICE	$1,299	$859	$719	$469

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7nm were outweighed by the difficulty in procuring the wafers.

TDP, as noted, remains at 105W maximum, but that's not the real maximum. Short-term boost can go 35 percent higher than the TDP, so chips with a 105W TDP can actually run at up to 142W (and often will do so in enthusiast motherboards). The 65W chips, meanwhile, can run at up to 88W. There's a 142W maximum power limit on socket AM4 that remains in place (though obviously overclocking can exceed that).

AMD is also choosing to keep with its Ryzen 3000 XT series philosophy of not including a box cooler with anything above the Ryzen 5 line. That means the Ryzen 5 5600X will be the only CPU that comes with a cooler. The 5800X, 5900X, and 5950X will all require an aftermarket cooler, and AMD recommends liquid-cooling solutions.

Zen 3 performance preview

We'll had the full review of the Ryzen 5000-series CPUs in APC 488 (Christmas issue). Our benchmarks revealed extremely impressive performance, with a single-threaded result on the Ryzen 9 5900X of 631 for Cinebench R20, compared to 524 for the 3900X. That's right in line with AMD's 19 percent IPC claims, and perhaps more importantly, it's also a significant jump from the score of 544 on the Core i9-10900K. Not only is AMD faster, but it does so while using significantly less power.

Perhaps more important than 3D-rendering performance, AMD makes no apologies when it comes to gaming capabilities. In our own testing, the Core i9-10900K was around 10 percent faster across a gaming test suite at 1080p ultra using an RTX 2080 Ti. Across a test suite of 10 games, AMD shows the 5900X matching or beating the 10900K – not by a lot, but it's better than trailing.

Incidentally, AMD has a new feature it calls Smart Access Memory that will improve gaming performance by around five percent when you pair a new Zen 3 CPU with a Big Navi GPU.

That brings up a few final interesting items of note. Intel still doesn't have a desktop PCIe Gen4 platform, and it won't until Rocket Lake arrives – which will probably be in March 2021. Intel is promising up to 18 percent IPC gains for single-threaded workloads with Rocket Lake, along with PCIe Gen4 capability. The problem is that Rocket Lake will apparently top out at an eight-core/16-thread configuration. AMD currently enjoys a PCIe advantage, a process technology advantage, and a core-count advantage. And Intel's first SuperFin desktop chips may not arrive until late 2021.

This is potentially the biggest lead AMD has had relative to Intel since the early days of Athlon 64, more than 15 years ago. Perhaps it's no surprise that AMD increased prices by around $100 across its suite of Ryzen 5000 CPUs. Intel, meanwhile, appears to be countering with price cuts, but even that may not be enough to stay competitive in the coming year. ■

Your X570 motherboard will be fine if you want to upgrade to Zen 3.

Other Zen 3 Architectural Updates

Besides the reworked L3 and CCX, Zen 3 offers numerous smaller changes. Overall, AMD claims a 19 percent improvement in IPC. A big chunk of that comes from the L3 cache, but it still means a 4GHz Zen 3 chip will generally perform as well as a 4.75GHz Zen 2 chip – or that a 4.4GHz Zen 3 CPU would be the equivalent of a 5.25GHz Zen 2 chip, which of course never existed.

Zen 3 CPUs also have 24 percent better power efficiency compared to Zen 2 running at the same clocks. Improvements to TSMC manufacturing help to boost clock speeds a bit, so TDP isn't lower. The L3 cache design also contributes to the lower power use, since a reduction in signaling traffic over the Infinity Fabric will cut power use. Combined with TSMC's improvements in its manufacturing, the net result are higher clock speeds.

That's about it as far as architectural changes go. AMD hasn't revealed all of the details, but the biggest change will be the move to a unified L3 cache and eight-core CCX. Even the compute chiplets haven't significantly changed in size. The Zen 2 compute chiplets were about 74mm square, and the new Zen 3 compute chiplets are at most 80mm square. That's not too surprising, as the dual-compute chiplet plus cIO chiplet form factor precludes using anything significantly larger for the die size.

VIRTUAL MACHINES MADE MANIFEST

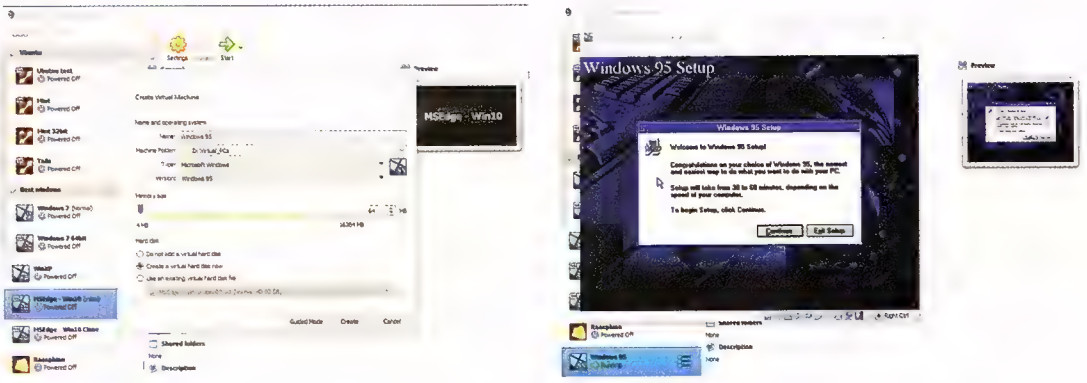
There's so much we share, it's time we're aware, it's a virtual world after all.

NEIL MOHR

These days it's one of the less-crazy conspiracy theories that the world isn't real and that all of this – peers around the decaying *APC* office – is an elaborate virtualised simulation run by some bored alien teen on their Apple IIq quantum computer. Brushing aside simpler questions such as, "Why?" and, "Could they bump up my pay cheque please?" it shouldn't mask that the modern world is in fact now largely run in a virtual world.

This text is being run as part of a Java Virtual Machine inside a browser. It's stored in the "cloud" as a managed virtual storage pool that'll be maintained as part of a Kubernetes orchestrated virtual containerised system. The webpages we've read to research this will have been served off high-availability load-balanced virtual server clusters, and the music-streaming service entertaining us while we write will be from a similar server farm. The list goes on.

This is very much the commercial end of our virtual world, where complexity is abstracted away behind automated software layers for easier management. As virtual technology advances into the GPU realm it's now orchestrating game-streaming services and enterprise-accelerated 3D desktops. But even on your personal machines this same abstraction can help you manage your own suite of virtual machines for running and testing software from Linux servers to old Windows builds, DOS games and more. So let's look at the tools being used, how you can run virtualised machines, and how the virtual technology extends to GPUs.



Far left: It's hard to contain yourself when moving those sliders, but less is more when it comes to legacy systems.

Left: 60 minutes you say? Eat my virtual dust!architecture.

The key to virtualisation success is ultimately financial, and by financial we mean laziness. Banks of virtual servers can be spun up on demand and dismissed when no longer required. This makes system-administration jobs easier but means that services can scale easily – up and down – depending on demand. This minimises overheads and can ultimately be made an automatic process.

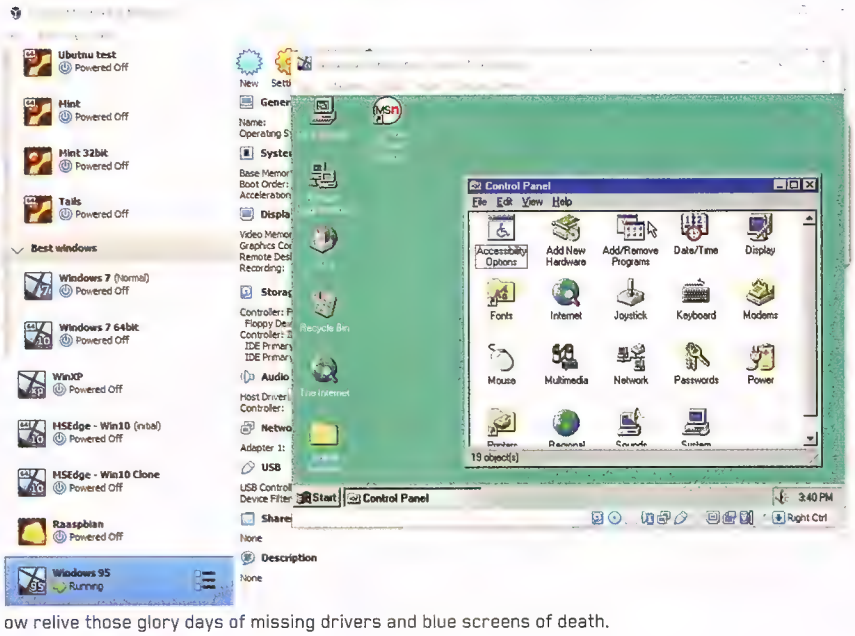
While this technology might be first aimed at 22-core Xeon servers, your Intel Core i5 or AMD Ryzen still packs the same hardware-virtualisation technology as those server systems. While we might not be running systems on quite the same level, we're still going to reap the advantages both from the hardware and the open-source software development.

Long-term readers might recall we ran a VirtualBox guide back in 2018. This covered v5.2 of VirtualBox, but since then the v6.0 release happened, and at the end of 2019 v6.1 was released. A major reason was the integration into the Oracle Cloud service alongside a GUI overhaul, but another addition was the shift to the obscurely named VBoxSVGA (also VMSVGA) support.

VMSVGA stands for VMware SVGA (the default for Linux) and is using a VMware-developed display driver, which is more efficient than the old VirtualBox VBoxVGA driver and still faster than the more recent VBoxSVGA driver (Windows default). Both support OpenGL 2.1 and DirectX 8/9 acceleration with Windows once you've installed the VirtualBox additions.

There used to be a system called PCI Passthrough – we'll talk about this in another context later – which was a hack that "passed" PCIe transfers from a spare GPU "through" to the virtual machine itself. It gave a suitable VirtualBox VM near full-speed GPU acceleration but was more of a workaround hack rather than a true virtualised solution. It was also hardware-inefficient, as the GPU had to be dedicated to a single guest VM and couldn't be used by the local host, and it had security issues. So this feature was removed with the v6.0 release onwards, while the old VBoxVGA driver option was removed with v6.1, apart from some exceptions.

"Cast your mind back 25 years and remember that original Windows 95 install discs couldn't boot! The olden days certainly were terrible."



ow relive those glory days of missing drivers and blue screens of death.

Virtually old

To get acquainted with VirtualBox 6.1 let's get a legacy Windows 95 guest system up and running. Try and think in terms of mid-90s PCs, so memory and storage are all in paltry megabytes. We're sure you've got an old Windows 95 install CD knocking around in the attic. Ideally you'll want to image this as an ISO image – head to **imgburn.com**, the classic Windows-based tool for imaging optical discs. Remember, Windows 95 is still copyright to Microsoft, so it's illegal to go for easy-to-download pre-built Windows 95 OSR2 ISO images on that internet.

Cast your mind back 25 years and remember that original Windows 95 install discs couldn't boot! The olden days certainly were terrible. It presumed either an install of Windows 3.1 would be in place or you had a floppy boot disk to hand. You can again get an image of a suitable boot disk at **allbootdisks.com/download/95.html**. For Windows 95a grab that IMG file, but if you're using the "latest" Windows 95 OSR2 release then the 95b.img is super.

With images to hand, we can start creating a suitable virtual guest in VirtualBox. Click "New > name this Windows 95," and this will set the memory to a sensible 64MB. Creating a virtual drive, Windows 95 uses the FAT16 filesystem, so the maximum drive size is 2GB – this is auto selected.

At this point VirtualBox creates the guest, but we need to tweak the settings, so click the "Settings" button. VirtualBox these days will select sane defaults that are worth going over. Windows 95 can only use a single core processor, and you'll need to keep hardware virtualisation off (it'll work but can throw up issues/blue screens of the death-type during use), as well as

3D or 2D – this should all be auto selected. Similarly the older PIIX3 chipset, PS/2 Mouse and SoundBlaster audio will be automatically chosen.

Under "Storage" you'll need to point the "Floppy Device" to your floppy image and the "Optical Device" to your Windows 95 ISO image, both under the "Storage" section. If your files are "raw" IMG files, when selecting these change the filetype in the "Explorer" dialog. Click "OK" to save the settings.

Hit "Start," and wrangle Windows 95 on this system. The floppy image should boot you to an A:\> prompt. If not, ensure you have a correct floppy boot-disk image, the virtual machine has a floppy device attached and it's pointing at the correct file.

The virtual guest will "capture" the mouse and keyboard input, press the right Ctrl key to jump back out. Type "fdisk", press Return, choose "Large Disk" support so we can make use of that HUGE 2GB of space (oh the luxury, you lucky millennials), select "1 > 1 > Y" and Escape. That's creating an active primary partition using all the space. Select "Input > Keyboard > Insert Ctrl-Alt-Del" to force a reboot.

Now format the C: drive with "FORMAT C." Time to install the Windows. Typically the optical drive will be R:, so type "CD R:\" and "R:" to switch to it – the drive letter is displayed when the driver starts as the floppy boots. We'll cover installing off the CD-ROM; this can cause headaches down the line, as driver updates will constantly be looking for the CD drive, which can change or not be mounted at all. To avoid that you can install all the install-files over with "xcopy R:\ C:\INSTALL\ /S," and install it from there.

Either way, type "setup" to kick things off. Don't forget your legit Windows 95 licence key. When prompted, select "Network and Sound cards." Let the install run – it's super quick weirdly. Before rebooting select "Devices > Floppy" and remove the bootdisk. It's also worth going into "System" and moving the boot order of the hard drive before the optical drive – if it needs to install drivers, check the next section first...

Now, if you're running an AMD Ryzen system, when Windows 95 reboots you'll likely run into a hilarious Windows bug that gives you an "Initialising Device IOS: Windows Protection Error" error of death message. This can occur on any AMD system faster than 350MHz (Outrageous!) and potentially Intel CPUs over 2.1GHz. Head to **http://lonecrusader.x10host.com/fix95cpu.html**, download and extract the Fix95CPU patch. This implements a Microsoft solution via an ISO file. With the Windows 95 guest off, add the FIX95CPU.ISO file and boot. Skip the readme and run the patch, then remove the ISO file and everything should boot fine. Remember to replace the Win95 ISO and adjust the boot order for driver installs.

We don't remember Windows 95 being this bad? We're probably remembering Windows 98, where many, many issues had been fixed. The bad news is you're probably stuck with 640x480 in 16 colours, as there's no official fix for this with VirtualBox. Windows 95 was never a real target for VirtualBox guests – you could track down the defunct SciTech Nucleus Driver ISO, which can open 1024x768 resolutions at 32-bit color, which is proper fancy.

The good news is you can get online with some minor tweaks. Right-click "Network Neighbors icon > Properties." First add in the "Microsoft > TCP/IP Protocol," then remove "Client for NetWare" (silly Novell), the NetBEUI and IPX protocols. Windows 95 will want to reinstall drivers from the CD-ROM, so check that the drive letter matches in the pulldown. After a reboot, you can run "winipcfg" to check you have an IP address assigned. We added our router IP to the" Gateway TCP Properties," which seemed to help.

You can jump on to websites, but you'll find the ancient Internet Explorer lacking JavaScript and modern HTML5 to be utterly useless, but it's all a bit of fun! Perhaps try and get a suitable build of Netscape, but otherwise we're up and running!

Remote access

A neat trick we like to use with VirtualBox is its ability to enable a Remote Display Server – much like remote desktop it enables someone on the network to remotely access a running virtual machine. If you use it alongside the "headless" and Detachable VM modes, you can make a guest machine of any type you like, available to anyone able to access your local network with a suitable RDP client. All you need is the IP address of the host PC; on a Windows PC press Window key, type "cmd", then type "ipconfig" and read off the IPv4 address.

We're going to presume that you have your VM guest already set up, so we'll tweak an existing VM. In VirtualBox select the VM you're interested in, then click "Settings," select "Display > Remote Display > Enable Server."

You'll see that the default port is 3389. The quick among you may have realised that this is the default Windows RDP port, so if you happen to use RDP already you'll certainly want to change the port. It would be wise to do so anyway to avoid head-scratching conflicts down the line. Additionally, only one running VM guest can utilise a specific port at a time on a

Using Intel GVT-g

Of course it's only available on Linux – an Ubuntu 20.04 install will do – and the official Intel guide (**http://bit.ly/maxpcgvt**) is pretty deep. The official Arch guide (**http://bit.ly/maxpcarch**) can be followed, but requires a good few asides for the uninitiated. The most user-friendly guide we spotted is at **http://blog.tmm.cx**. The four-step process covers:

CONFIGURING THE HOST MACHINE

Largely this involves installing the software then configuring the kernel and bootloader. The Linux kernel has KVM built directly into it – this is the Kernel Virtual Machine, so there are standard libraries (libvirt, virt-manager) for initiating virtual machines. Alongside this is Qemu, the standard hardware-emulator system that can emulate everything from ARM to x86. Also required is a SPICE server that helps manage virtual desktops, plus VirtIO drivers for Windows. The kernel needs a few parameters set at boot time so that it knows to expect GVT messages and to have the correct modules loaded.

CREATING THE VIRTUAL GPU

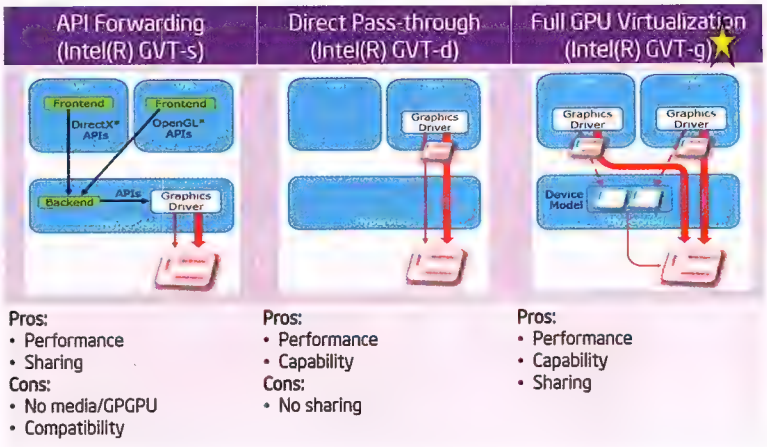
If everything is working, this is a case of creating a Linux kernel UUID (universally unique identifier) for the device and appending it to the device config, ensuring it has enough VRAM to work in the first place. Once that's done, you create a Linux systemd service to ensure that it's started each time the system boots up.

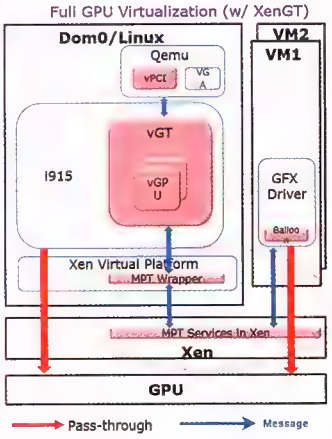
SETTING UP A WINDOWS VM

This uses Qemu/KVM to install the Windows guest with CPU passthrough and use the VirtIO drivers. Once up and running the SPICE server additions can be installed. When the basic Windows 10 VM is set, the configuration needs to be edited to support the virtual GVT-g GPU. This involves editing the rather large XML config file.

ENABLING GVT-G

At this point, when the virtual machine is started it'll almost be like Windows 95, with software-rendering limiting the resolution. Windows now requires the correct Intel DCH graphics drivers, tweaking the system to support a wider range of resolutions and checking that DirectX 12 is supported.





Far left: These are the three main modes for virtualising GPU access and how they work.

Left: A more in-depth look at how the Intel GTV-g system works along with the Xen architecture.

"The last big area in virtualisation that needed tackling was GPUs. It wasn't until after the mid-2010s that full virtualisation solutions started to appear, but only aimed at enterprise and professional markets."

system, so if you plan on using this with more than one VM guest this will need to be changed for each. Oracle recommends ports between 5000 and 5050, so start with 5000 and increment.

Once you've selected that, on the same PC press the Windows key and type "RDP < Run Remote Desktop Connection." As you're on the same PC as the virtual guest, in the RDP window use 127.0.0.1:5000 (this is the local loopback address and your port), it should connect. On a remote PC on the same network you'd do the same but type "<ipv4 address>:5000" and click "Connect." From a command prompt you can type "mstsc -v <ipv4 address>:5000" for the same result.

As a quick aside, Oracle supports limited remote USB access. A VirtualBox guest can access the USB devices of the remote computer on which the VRDP data is being displayed, just as if the USB devices are connected to the actual host. The trouble is Oracle only provides a Linux RDP client capable of this.

If you're interested in remote access, also know about Headless mode. This launches the VM without a window, just for remote access. It can be launched from the GUI by clicking the down arrow next to the Start button.

Virtual graphics

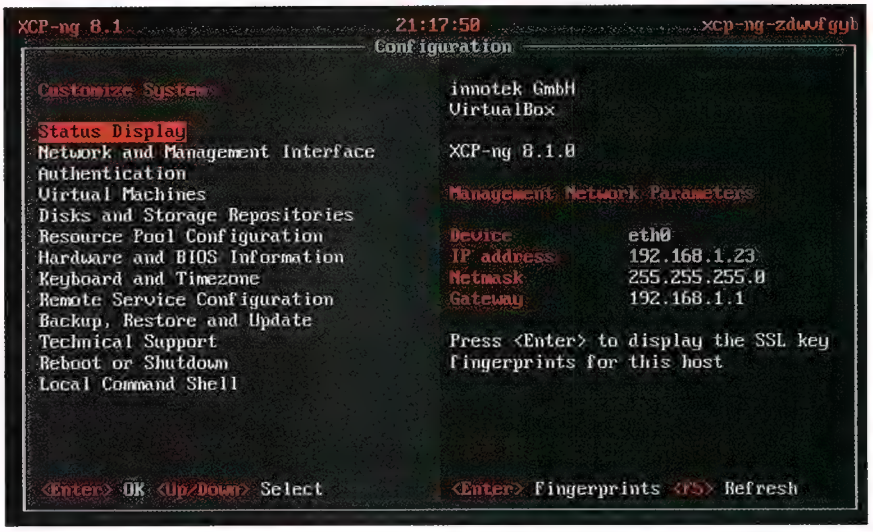
The last big area in virtualisation that needed tackling was GPUs. It wasn't until after the mid-2010s that full virtualisation solutions started to appear, but only aimed at enterprise and professional markets. Services like Nvidia GRID, which it uses to power its GeForce NOW service, and AMD Radeon MxGPU enable GPU and compute capabilities to be delivered from data centers to networked workstations in a secured environment. Due to the price mark-up these specialist areas command, it means that much of this technology hasn't been opened up to consumers.

One such area that has is PCI passthrough. It's delivered by the virtualisation software using generic GPU hardware and is more a hack than offering any true virtualisation abstraction. It offers high performance and is simple to implement, but is very wasteful with hardware, as only one guest OS can utilise the GPU, and the host is locked out too.

Another generic software workaround is called API forwarding or API remoting. Using a special virtual GPU driver on the guest, any 3D calls to the GPU API are forwarded to the host system, where they're run on the real GPU hardware. The advantage is that multiple guests can access the GPU. The downside is efficiency – performance at best is 80 percent but can be as low as 15 percent, depending on what calls are being run – and there are security concerns, as memory could be shared between guests for efficiency. It does have the advantage that calls can be network routed for added flexibility.

The ideal fully virtualised solution should offer full API compatibility i.e. OpenGL 4.x, DirectX 11/12, OpenCL and CUDA support, with high performance and shared hardware between guests and hosts. This has been the final sticking point for the virtual world, even considering the prodigious amounts of money floating around the likes of Nvidia, AMD, and Intel.

Nvidia offers a range of virtualisation solutions, including Virtual Compute Server (vCS), Quadro Virtual Data Center Workstation (vDWS), GRID Virtual PC (vPC), and Virtual vApps. AMD has its AMD MxGPU technology to deliver up to 16 VMs per GPU over a network. This arrived in 2017 with its Radeon Instinct line that was aimed at deep-learning networked solutions. But these are all enterprise and professional-class solutions.



The XCP-ng server up and running in all its DOS GUI glory.

The only widely available consumer GPU virtualisation technology is from Intel, under its Intel Graphics Virtualisation Technology (GVT). Initial versions of this were released by Intel over 2014/2015. It's been rolled out in three forms and should work with 5th-generation (Broadwell) processors onwards on Intel's integrated graphics.

Intel offers GVT-d, GVT-s, and GVT-g. The first, -d, is direct passthrough, which is less than ideal. For single VMs use it's worth considering, but using the onboard Intel graphics as your primary display won't be an option. The "-s" stands for "Shared" and enables multiple virtual guest access to a single physical GPU via API forwarding. It's more flexible for multi-guest use, but there's no GPGPU support and again no host access.

The solution everyone should be interested in is GVT-g and its full GPU virtualisation, full API support, near-full performance, and shared access. The Intel virtual driver supports up to seven virtual guests on top of the host.

The bad news is there's no Windows host support for this at all. We guess this is because it involves the kernel to be updated and configured to handle the redirected virtual calls, and Microsoft has no interest in investing resources to make this viable for consumers to use.

There is a Linux host solution (because of course there is), but setting this up is, erm, quite involved (see the boxout), but once done you get near full-speed GPU acceleration on Ubuntu and Windows 7/8/10 Guest OS. So it is of genuine use for developers who need access to multiple OSes.

Virtual orchestration

While hunting around for an "easy" virtualisation solution that supported the various GPU passthrough modes we stumbled upon the **http://xcp-ng.org** project. This is a Turnkey (read: easy to install) server virtualisation solution, based on the industry standard open source Linux XenProject.org.

If you have dedicated hardware available and you're wanting to run and manage virtual machines, then this is well worth a look, but keep in mind it's a server installation, so it's set to take over the entire machine/install drive and be remote-administered. If you have a spare drive then you could swap out the existing boot drive on a machine and install this to give it a go.

Once it's set up and running (that can be done in five minutes) it's designed to run headless (without a monitor) so can be entirely managed from a web interface, but for you Windows types the community maintains an unofficial Windows XCP-ng Center **https://github.com/xcp-ng/xenadmin** at v20.04 as of April 2020.

The good news for us is that if you have the right hardware, XCP-ng can support GPU passthrough on virtual guests. For Intel graphics that's GVT-p and GVT-g; if you have "dumb" consumer GPUs it'll provide direct passthrough, while if you have access to "pro" cards like Nvidia Quadro or AMD MxGPU-enabled Radeon Pro/FirePro cards, full GPU virtualisation can be utilised.

If you want to try a full hypervisor solution, we'll give you the key pointers on how to get it installed and up and running with GPU passthrough. But you're going to have to figure out the minor steps yourself – it's a professional solution, so be prepared to read one heck of a manual.

Head to **https://xcp-ng.org/#easy-to-install** and grab the install ISO, write this to a USB stick and boot your spare "server" system with it. Please ensure you know the correct blank drive to install it to – you can also use this to store the virtual machines. When asked, use the local files and ignore the add-ons. You'll be asked to create a password, remember this, as you need it to remote-log in. If all goes smoothly it'll reboot to a classic DOS-style XCP-ng main menu that tells you the IP address of the PC, but ignore this.

On another networked Windows PC, download the latest build of XCP-ng Center and install it. Ensure your XCP-ng server is running on the same network, and choose "Add Server." Enter its IP address and the password you created for it. We'd strongly suggest you use a network shared folder to store your ISO images for installing virtualised guests. Oddly we had one up and running already. Select the server, click "New Storage > ISO Library > Windows File Sharing." You'll need the network path to your server //<server name>/<iso folder> if you have set for public access use the username guest, otherwise enter the access credentials.

Use "New VM" to create a new virtualised guest. We're going with Windows 10 – at this point it's very much like VirtualBox to create a VM, but "Installation Media" provides a drop-down of your stored networked ISO files. We'd add the GPU later, because if there are any issues you'll end up with a blank screen. Before starting the VM you need it to boot the DVD image. select the "VM > General > Properties > Boot options" and move the DVD drive to the top, then hit "OK." Start the VM and switch to the "Console" tab to interact with the VM and install your OS!

So there we are, a quick tour on the current virtual world, from one-off virtual guests in VirtualBox to super-orchestated guests using Xen and XCP-ng alongside GPU virtualisation. ■

Hardware acceleration

Any processor made in the last 15 years (since the introduction of the Intel Core range) will likely have some form of hardware virtualisation. AMD joined Intel a year later in 2006, adding the first hardware extensions to its Athlon 64 "Orleans" models onwards and Phenom II processors.

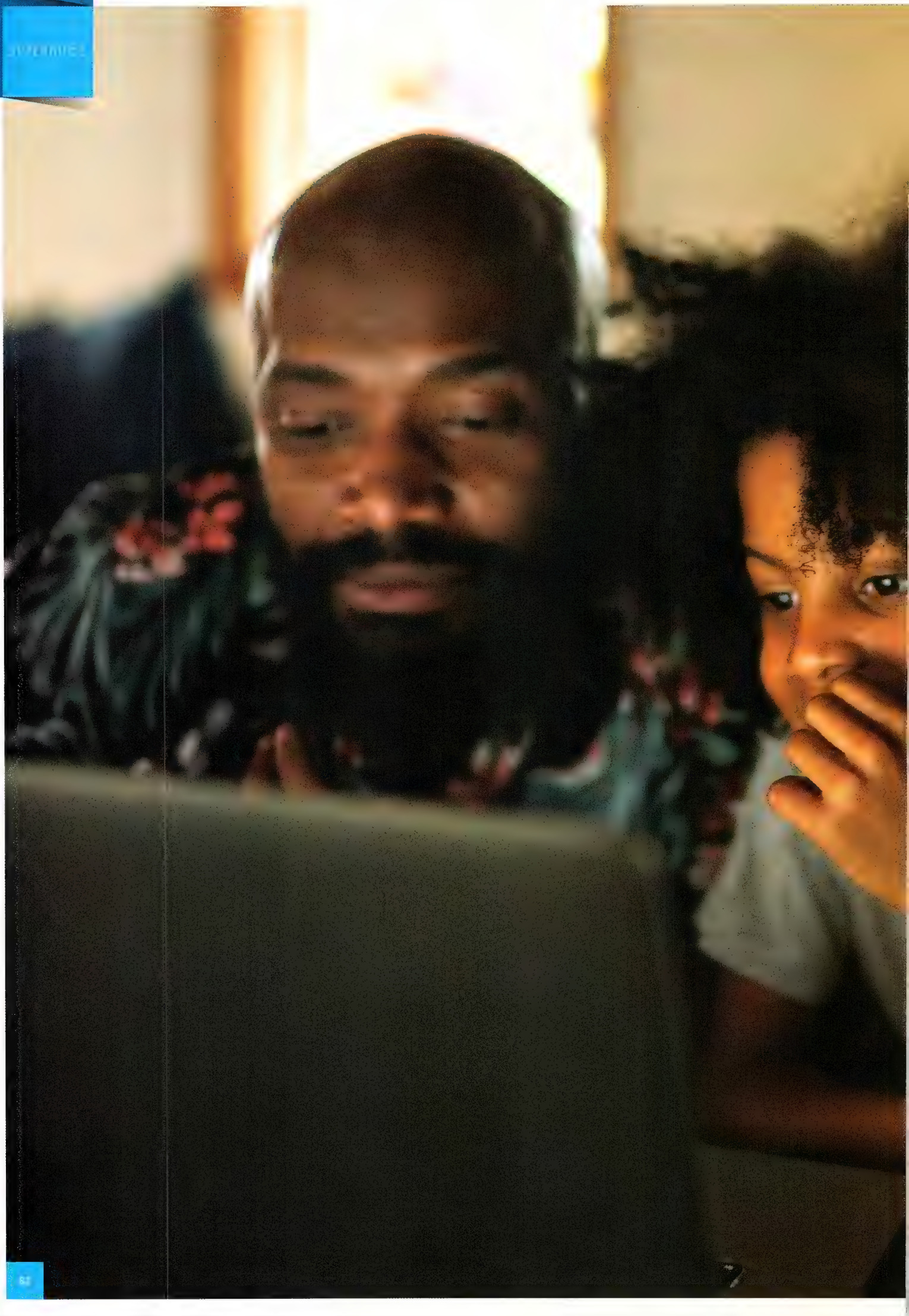
Early on these features were sometimes disabled in the BIOS, and even today there can be BIOS virtualisation options tucked away.

Hardware virtualisation implements internal hardware systems that enable the processor to faster switch the processor state between serving the host OS and virtual guest. The hardware extensions enable the hypervisor to effectively switch the whole CPU context between the local OS and hypervisor VM code, to register interrupt handling, instruction calls, and critically handling the remapping of memory calls alongside I/O and DMA access.

Both AMD and Intel introduced a range of processor features. The initial features, called Intel-x and AMD-v, provide instructions to rapidly switch the guest to a privileged state to run trapped calls. AMD also added Rapid Virtualisation Indexing, followed by Intel EPT that virtualises memory page-table look-ups. Benchmarks show that these increase kernel-level performance to five fold depending on the workload.

AMD-Vi and Intel VT-d provide an I/O memory management unit also called PCI passthrough. It enables the guest OS to access hardware seemingly directly, via a translation table on the host. Both processor and motherboard need to support the feature and you may need to activate this in the BIOS.

Building on the I/O features, virtual interrupt support was added shortly after IOMMU. AMD with its AVIC (Advanced Virtual Interrupt Controller) and Intel with its APICv. Both are designed to route virtual interrupts to the correct real CPU.



BUILD A JELLYFIN MEDIA SERVER

Set up your own powerful – and completely free – alternative to Plex and Emby with Nick Peers.

Anyone who loves to stream media from their own personal library will have heard of Plex or Emby. Both offer an amazing user experience and powerful features, but they also come with one major pitfall: The need to pay a subscription to access their best features, such as live TV and DVR support, as well as hardware-accelerated transcoding. Those subscription costs can soon mount, but the good news is that there's a completely free and open-source pretender to their crown coming up fast in the rear-view mirror.

The usurper in question is Jellyfin. Although it only came into existence a mere two years ago – forked from the last open-source release of Emby – it's developed swiftly into a genuine rival to its established peers, boasting all their best features, including those hidden behind the Plex Pass or Emby Premiere paywall. That's in no small measure because it's promised to avoid commercialisation, which has in turn attracted a flurry of donations and developers to the project.

Read on to discover what makes Jellyfin a viable alternative to its better-known peers, and learn all you need to know about setting up and running your own Jellyfin server for the benefit of you, and your household.

Getting started

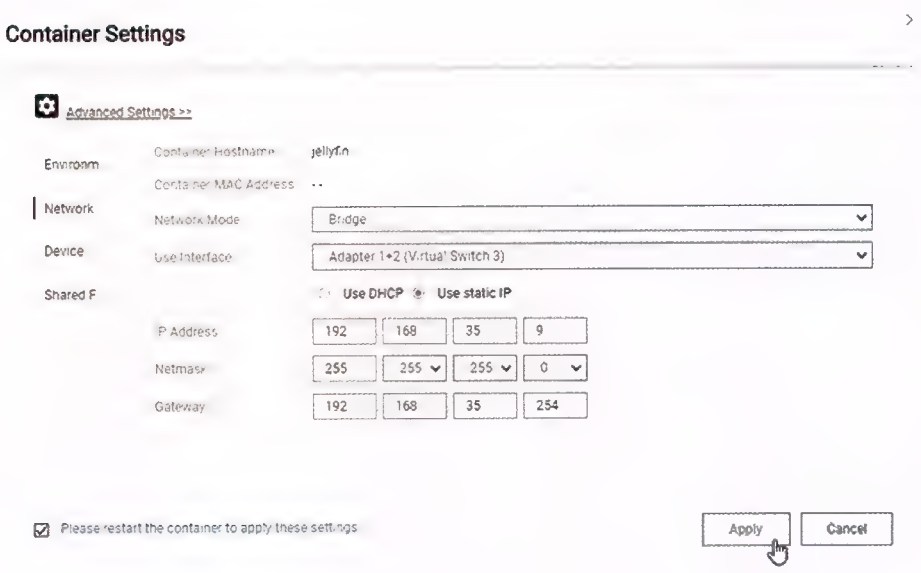
As we've stated, the obvious reason why you'd want to tear up your Plex or Emby installation and start again with Jellyfin is cost – the latter's promise to remain free and open source forever instead of chasing the dollar sign means that the features you can enjoy now will never be hidden behind a paywall. That's all well and good, but surely all this free goodness comes with a catch, right?

Not really: Sure, Jellyfin isn't quite as polished as its rivals, but all the core functionality is there, and thanks to its origins, you don't have to reinvent the wheel to switch from Plex or Emby. You won't need to rename or reorganise any of your existing media collection at all to get the most out of the software – just point Jellyfin to your existing media folders and it'll do the rest.

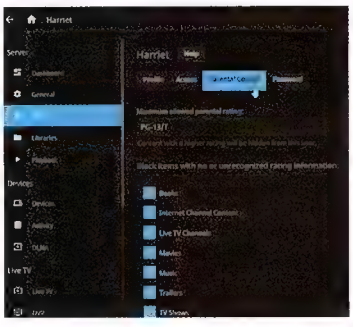
Jellyfin's user interface will – unsurprisingly – be instantly familiar to Emby users, and it doesn't take much work for Plex users to switch either, although you'll find that Jellyfin's UI isn't quite as intuitive (on the upside, it offers a lot more control). The blue and purple colour scheme is fully customisable too, and everything is very pleasing on the eye, with plenty of familiar elements to help you acclimatise to your new environment. One area where Emby and Plex still hold an advantage is with client support, but as the boxout opposite reveals, Jellyfin is closing the gap fast.

Local authentication

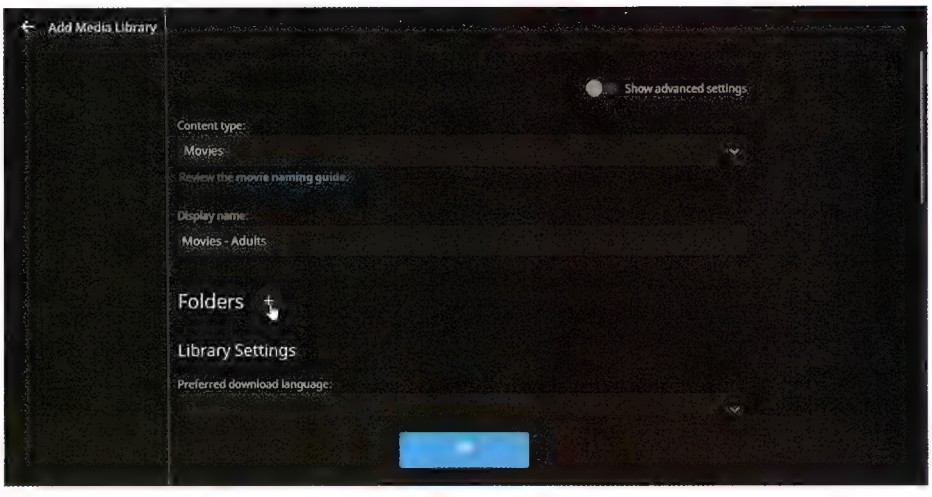
One major plus in favor of Jellyfin is that it doesn't use any cloud-based authentication for users. A Plex.tv account is mandatory for both local and remote connections in Plex, while Emby Connect is required should you wish to open up access to your Emby server over the internet. Jellyfin ditches both in favour of continuing Emby's original approach: Direct connections to your server, with user profiles set up and managed locally, and no centralised harvesting of your data (or the privacy implications that come with it). On the downside, setting up remote connections requires a more work, but follow our advice in the "Remote Access" box and set up a secure connection for trusted devices through a reverse proxy.



QNAP NAS users should install Jellyfin through Container Station.



Left: The Dashboard is where you configure all aspects of Jellyfin, including its users.
Below: Configure your first media library during setup.



And what about features hidden behind Plex's and Emby's respective paywalls? Jellyfin provides support for live TV and DVR – not as advanced as its rivals, but still usable. It also supports hardware-accelerated transcoding using your server's graphics card to reduce the burden on the CPU.

Hardware considerations

The Jellyfin server can be installed on Windows, Mac, and a range of Linux distros, and it can also be installed using Docker (although hardware acceleration is harder to apply in a Docker container). In terms of raw hardware, Jellyfin can be run on quite modest setups, particularly if you can minimise "transcoding."

Transcoding occurs when your client device doesn't support the file format of your media. It's normally pretty CPU-intensive, which is why hardware acceleration can make all the difference, transferring some of the burden onto your graphics chip or card. Jellyfin's support extends across all major platforms, including Intel (QSV), Nvidia (NVENC), and AMD (AMF).

Of course, the best approach is to avoid transcoding entirely. By ripping your media in a universal format (MP4 container, H.264 video codec, AAC audio codec), you should find that most of your clients can stream the files without requiring any transcoding, thus reducing the demands on your server. Minimise transcoding, and you'll find that Jellyfin runs happily on a mid-range SOHO NAS, such as our QNAP TS-251+ NAS with 2013 quad-core Celeron CPU and 8GB RAM, or even

a Raspberry Pi 3 or later.

One final consideration is the speed of your internet connection. If you plan to open your server to remote access over the internet, for your own on-the-road use or to share media with your household, then you need to benchmark your upload speeds using the likes of Speedtest (**www.speedtest.net**). Compare these results with the typical bitrates required to stream content to determine how many remote streams your connection can handle simultaneously.

Install Jellyfin

Time to install Jellyfin onto your server. Head to **https://jellyfin.org/downloads** where you'll find links to downloads for Windows (both portable and installer) and Mac, plus terminal commands for various flavors of Linux and Docker. While Jellyfin provides its own official Docker image, we made use of Linuxserver's Jellyfin container (**https://hub.docker.com/r/linuxserver/jellyfin**) for our QNAP thanks to its easy configuration. We also chose a bridged network rather than the NAT settings, for two reasons: One, it simplifies setting up secure remote access; and two, it ensures that live TV can work without problems.

Whatever your method of choice, installation is simple, and once complete you're ready to log on to the server through a web browser. Head to **http://192.168.x.y:8096** (substitute **192.168.x.y** for your Jellyfin server's internal IP address, or **http://127.0.0.1:8096** if you're accessing it from the same computer it's installed on).

The first-run wizard will appear – Emby users will recognise it instantly – which is easy to work through. Start with your preferred display language (English United States is the default). Click Next.

Your next job is to set up the master user account for Jellyfin. This will be your account, and you'll have full access to all aspects of Jellyfin, including server management. Give yourself a suitable username ("Bob" for example) and don't skip the option to password-protect it, particularly if you plan to share your Jellyfin server over the internet.

Configure your first media library

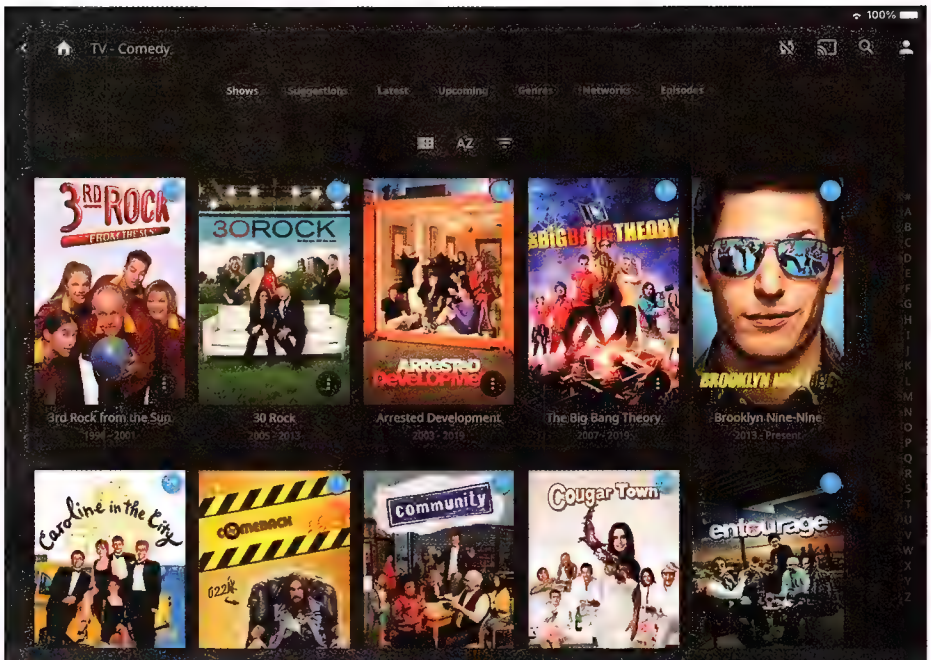
You will now be prompted to set up your first media library. Click "Add Media Library" to get started. Start by choosing your content type: Movies, Music, TV Shows, Books, Photos, Music Videos, and a catch-all Mixed Content are all available. Your library will be named for the content type you pick, but you can edit this as you see fit.

Next, click "+" to select the folder (or folders) containing your library's content. Once done, scroll down to access library-specific settings. Set a preferred download language and country that will be used to display the information about the content in your library.

Beneath this are the "scrapers" Jellyfin will use to populate your library with metadata and artwork. Untick any you wish to ignore, or click and drag to rearrange the order of preference in which they're used. Finally, you'll see some settings related to how the downloaded data is stored – ticking "Nfo" and "Save artwork into media folders" will allow other media servers, including Emby and Kodi, to share metadata, but introduces clutter into those folders and requires write-access to your media folders, which isn't a given in Linux-based iterations of Jellyfin.

Flick the "Show advanced settings" switch at the top to reveal even more options, such as options to pull in artwork and whether you want to "download images in advance," which basically means downloading them when media is imported into your library instead of when requested by a Jellyfin app.

Once you've configured your library, click "OK," then repeat for any other media libraries you'd like to configure now (you can add

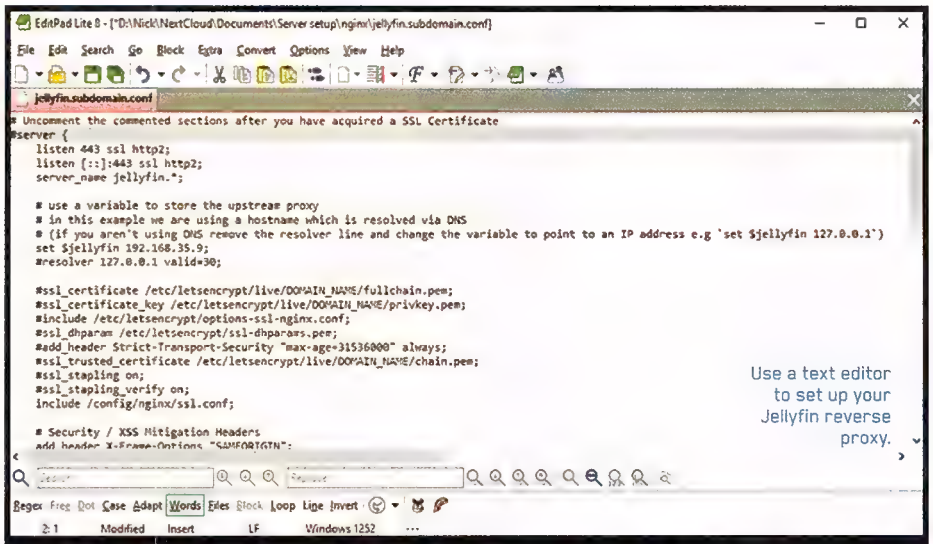


Access Jellyfin content

Any media server will live or die on how easy it is to access your content from a variety of platforms and devices. Over the past year, Jellyfin has worked hard to cut the gap between it and its longer established rivals, so that most major platforms are now supported – for free.

To see what platforms currently support Jellyfin, visit **https://jellyfin.org/clients/** – you'll find a range of releases (although beware, the Jellyfin for Desktop client currently has no official releases; try Jellyfin MPV Shim instead). Both Android and iOS are covered, along with a growing range of smart TV platforms: Boxes like Roku, Amazon Fire TV, and Android TV have native apps, while Apple TV owners can access Jellyfin content through the Infuse app. Also supported are Chromecast and AirPlay. Dedicated apps for Xbox One, Samsung (Tizen), and LG (webOS) TVs remain in development.

Once a client is installed and launched for the first time, you'll be prompted to enter your Jellyfin server address. If you're primarily connecting through your home network, use the local IP address (**http://192.168.x.y:8096 by default**) to enjoy a faster connection and fewer streaming restrictions. Many apps let you store multiple server setups, so simply add your server's remote address (**https://jellyfin.domain.com** for example) alongside it to provide access on the road when you need it.


EditPad Lite 8 - ["D:\Nick\NextCloud\Documents\Server setup\nginx\jellyfin.subdomain.conf"]
File Edit Search Go Block Extra Convert Options View Help
jellyfin.subdomain.conf
Uncomment the commented sections after you have acquired a SSL Certificate
#server {
listen 443 ssl http2;
listen [::]:443 ssl http2;
server_name jellyfin.*;
use a variable to store the upstream proxy
in this example we are using a hostname which is resolved via DNS
(if you aren't using DNS remove the resolver line and change the variable to point to an IP address e.g `set $jellyfin 127.0.0.1`)
set $jellyfin 192.168.35.9;
#resolver 127.0.0.1 valid=30;
#ssl_certificate /etc/letsencrypt/live/DOMAIN_NAME/fullchain.pem;
#ssl_certificate_key /etc/letsencrypt/live/DOMAIN_NAME/privkey.pem;
#include /etc/letsencrypt/options-ssl-nginx.conf;
#ssl_dhparam /etc/letsencrypt/ssl-dhparams.pem;
#add_header Strict-Transport-Security "max-age=31536000" always;
#ssl_trusted_certificate /etc/letsencrypt/live/DOMAIN_NAME/chain.pem;
#ssl_stapling on;
#ssl_stapling_verify on;
include /config/nginx/ssl.conf;
Security / XSS Mitigation Headers
Use a text editor to set up your Jellyfin reverse proxy.
Regex Free Dot Case Adapt Words Files Block Loop Line Invert
Modified Insert LF Windows 1252

Set up secure remote access

Remote access allows you to stream from your Jellyfin server over the internet. Unlike Plex or Emby, which use their cloud-based authentication systems to simplify the connection, you'll need to set this up manually. It's a good idea for security purposes to ensure all remote connections are secure (HTTPS rather than HTTP), and the easiest way to do this is through an existing reverse proxy.

Start by setting up a new subdomain (**jellyfin.domain.com**) with a domain you own. Now delete and recreate the container, adding your subdomain to the "SUBDOMAINS =" environment setting.

Once the certificate has been generated, shut down the container. Now copy and paste the code underneath "Nginx" from a subdomain at **https://jellyfin.org/docs/general/networking/nginx.html** into a blank text file, which you should save as jellyfin.subdomain.conf.

Remove the first server {} block listening on port 80 – this is handled by your main configuration file (default under site-confs). Next, Uncomment out the two "listen 443" lines and change "DOMAIN_NAME" to "jellyfin.*" Change **set $jellyfin jellyfin;** to **set $jellyfin 192.168.x.y;**, substituting your server's local IP address in place of **192.168.x.y**.

Add the following line beneath the ssl_stapling_verify_on; line:

include /config/nginx/ssl.conf;

Save the file, then upload it to the proxy-confs folder. Restart the container.

Now navigate to Jellyfin's server settings, then go to "Advanced > Networking." Tick "Enable HTTPS" and change the port number to 443. Click "Save." You should now have remote access enabled, and SyncPlay should work correctly too.

more later if you're impatient to get going). Click "Next" when done. Depending on the size of your media folders, setting up each library can take some time. You'll see content start to appear quickly, but it may take some hours before each library is fully populated.

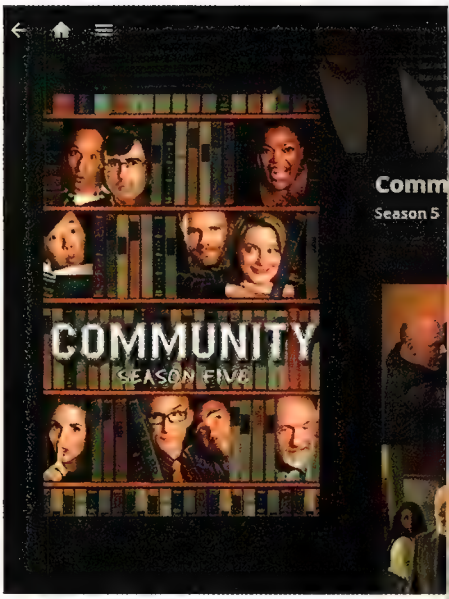
Next, confirm your metadata language and country settings (English / United States) and click "Next." The next step confirms whether you want to open remote access to your server (for streaming content over the internet) – enabled by default – and whether you'd like to attempt UPNP port mapping. If UPNP is disabled on your router, you'll need to manually forward ports to your server's IP address. For more on remote streaming, check out the box above.

Once configured, click "Next," and you're done. Click "Finish," and Jellyfin will start scanning your media folders for content in the background. This can take some time depending on your server hardware, so now's a good time to leave Jellyfin to its own devices for a while.

First-time login

You'll be shown to the main Jellyfin screen, which provides you with access to your media library with a variety of views: At the top are shortcuts to your individual media libraries, followed by the "Next Up" section, Jellyfin's equivalent of Plex's On Deck view for working your way through series. Beneath this you'll see the latest additions to each library.

Browsing any of these views is self-explanatory, with plenty of



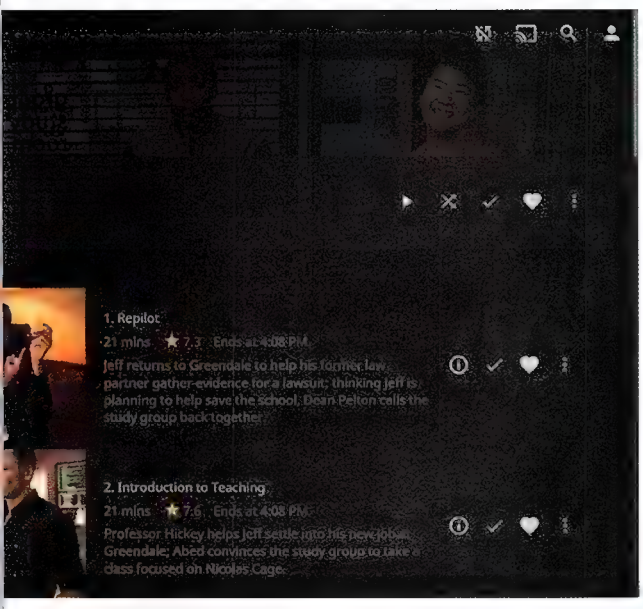
on-screen navigation aids. At the top are a range of library views, from "Suggestions" to "Genres." Look out too for "Favorites," which lists any media you've marked by clicking the heart icon next to it, and "Collections," which enables you to manually group related items together (such as all the movies in a specific franchise, or a more eclectic choice such as movies featuring a specific actor).

Immediately below this are three buttons, enabling you to change your library view from the default poster-based view, with banners, lists, and thumbs all available. Next to this is the A-Z button, allowing you to sort your library by different criteria, while the final button allows you to apply various filters to the view, from features and genres to parental ratings and years.

When you select a specific movie, TV episode, or other piece of media, you'll be whisked to its own page, where you'll hopefully see a synopsis, as well as a summary of the media's audio and video type. If the media item contains a choice of video, audio, or subtitles, then look for dropdown menus enabling you to switch from the default choices before playing your movie.

Fix metadata

As you browse your library, you're likely to come across the odd series or movie that has been incorrectly identified. To fix this – and to make other metadata-related changes to your libraries – click the hamburger button in the top-left corner of the screen to slide out the main Jellyfin menu and choose "Metadata" under "Admin."


1. Repilot
21 mins ★ 7.3 Ends at 4:08 PM
Jeff returns to Greendale to help his former law partner gather evidence for a lawsuit; thinking Jeff is planning to help save the school, Dean Pelton calls the study group back together.
2. Introduction to Teaching
21 mins ★ 7.6 Ends at 4:08 PM
Professor Hickey helps Jeff settle into his new job at Greendale; Abed convinces the study group to take a class focused on Nicolas Cage.

Jellyfin's easily navigable UI is packed with rich meta data and artwork.

The Metadata Manager reveals an Explorer-like view of your media by folder. Drill down to a movie title, or parent folder for a TV show, and you'll see its metadata appear in the right-hand pane. You can manually edit this if you wish, but if you're attempting to fix an incorrect match, a quicker method is to click the vertical ellipsis button next to "Save" and then choose "Identify."

This will bring up a search tool. You can search by title and/or year (which should resolve most issues where an identically titled show or movie from a different year has been selected), but if this doesn't yield a result, go online to **www.imdb.com** or **thetvdb.com** to manually locate your show and grab its ID. Enter this into the relevant search field, and you're guaranteed to get the right match when you click "Search."

Admin metadata

Jellyfin's server can be further configured via its Dashboard, also accessible under the "Admin" section of the main menu. Configurable options are split into four sections: "Server," "Devices," "Live TV," and "Advanced," with Dashboard at the very top. It provides a handy overview of recent changes, which devices are currently connected, what's streaming and where.

Beneath this is "General," where you can change your server name and preferred language, followed by "Users." If you're planning on sharing access to Jellyfin with other users – both locally and remotely – then you'll want to assign them own user accounts,

Name your files

Your media server uses the filenames of your media to help identify and tag them correctly. Jellyfin follows the same naming conventions as Plex and Emby, so if you're migrating from these you should have little trouble with most of your content.

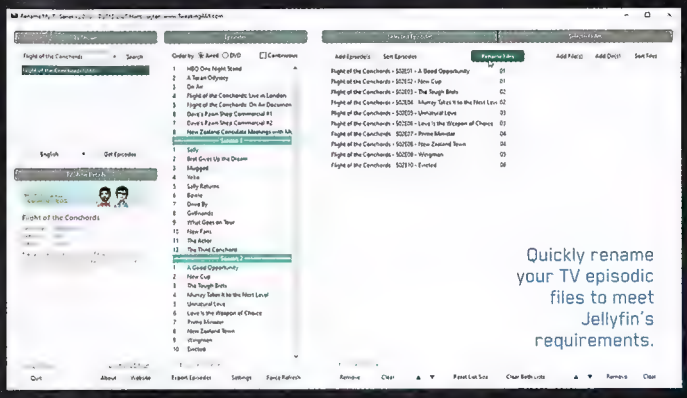
The only exceptions are likely to be TV series that share the same name as an earlier show, and any movie extras you have into the same folder as your original movie following Plex's naming conventions (see **https://support.plex.tv/articles/local-files-for-trailers-and-extras/**).

Regarding the latter, Jellyfin follows Emby's convention: Here, you simply create a subfolder called "Extras" inside the main movie folder, then move all your extras into there.

You'll also need to rename the file – for example, "Avatar-deleted.mp4" should be renamed "Avatar Deleted Scenes.mp4" or even just "Deleted Scenes.mp4," as its filename is the title that Jellyfin displays underneath the main movie.

If you are only just starting out with your first media server, then here is our recommended basic naming convention nomenclature:

TYPE	FOLDER STRUCTURE	SYNTAX	EXAMPLE
MUSIC	MUSIC\ARTIST\ ALBUM	00 TRACKNAME.MP3	MUSIC\A-HA\CAST IN STEEL\01 CAST IN STEEL.MP3
MOVIES	MOVIES\TITLE (YEAR)	TITLE (YEAR)	MOVIES\READY PLAYER ONE (2018)\ READY PLAYER ONE (2018).MKV
TV SHOWS	TV\SHOW TITLE\SEASON	TVSHOW - S01E01	TV\COMMUNITY\SEASON 6\COMMUNITY - S06E10.MKV



Quickly rename your TV episodic files to meet Jellyfin's requirements.

If you have multiple versions of the same movie – say a theatrical version and director's cut, or a 4K version for watching locally and an SD version for remote streaming – name each file like so: "Movie (year) - Version.mp4." "Version" can be anything you like – "1080p," "HD" or "Director's Cut" – and is displayed on screen to help you get the right one.

It's laborious to rename existing files by hand to meet these conventions, but various tools exist to make it easier: Filebot (**www.filebot.net**) covers music, movies, and TV shows, but costs US$6 (one-year license) or US$48 (lifetime license). If you're only interested in renaming TV shows, then Rename My TV Series 2 (**www.tweaking4all.com/home-theatre/rename-my-tv-series-v2/**) is completely free–and cross-platform. Change the filename format under "Settings" to "**%N - S%SZE%EZ - %T**" to match my recommendation above.

Extend Jellyfin with plugins

Like Emby, Jellyfin supports a wide range of plugins that provide access to all kinds of extra features and functions . Navigate to the Dashboard and click "Plugins" under "Advanced" to review them. You'll see that four metadata providers come pre-installed covering your music, movie, and TV libraries. Any with a vertical ellipsis button next to its name contain settings you can tweak by clicking the button and choosing "Settings."

Switch to the "Catalog" tab to see what additional plugins are currently available through the official Jellyfin repo. You'll see they're split into six categories: "Authentication," "Channels," "General," "LiveTV," "Metadata," and "Notifications." Click one for a description and options to install it.

You'll find plenty of potential interest: If you have a USB TV tuner then you'll find plugins supporting popular backends NextPVR, ServerWMC, and TVHeadend that you can configure to work with Jellyfin. An IPTV plugin provides support for IPTV, while Auto Organize lets you set up a folder that you can copy media into and let Jellyfin move across to the appropriate library folder.

Open Subtitles lets you grab subtitles from the internet for those movies or TV shows without them already embedded, while Playback Reporting echoes Plex's dashboard where you can view server activity, including a list of what each user's been watching.

The "Repository" tab is a recent addition and will in future make it easier for 3rd-party plugins to be developed and shared with the community.

which will give them their own custom access to Jellyfin, complete with their own personal deck for lining up TV episodes plus the ability to tweak certain aspects of their own personal experience. Click "+" to set up your first user: Assign them a name and password, and choose what libraries to give them access to. Click "Save."

Once a user is created, you'll gain access to four tabs of settings: "Profile," "Access," "Parental Control," and "Password." Under "Profile," you'll see options for enabling or disabling remote streaming, management of the server, and access to specific features, such as live TV, SyncPlay, and media downloading. "Access" is where you manage their access to both libraries and from specific devices, while "Parental Control" gives you handy control over children's access to content, with options for setting a minimum parental rating, plus limiting access by day and time. Use "Password" to assign a new password, or add a pin code. Click "Save" when you're done.

"Libraries" is – of course – where you go to manage existing libraries, as well as to add new ones (the process is identical to that in the first-run wizard). The final setting under "Server" is "Playback." Available options here include whether to use hardware acceleration for transcoding (if supported – remember, there may be a price to pay in terms of image quality, so experiment with both settings). You'll also find advanced conversion settings for transcoding to x264/x265 – Handbrake users should recognise most of these options, and it's something that sets Jellyfin apart from Plex.

Remember how we mentioned earlier about how your internet upload speed will limit the number of streams you can serve? One way to ration your available bandwidth is to make use of the setting under "Playback > Streaming." Here you can set a per-stream bitrate limit; any media with higher bitrates will be transcoded to fit whatever limit you set, so bear this in mind if you're streaming from a low-powered device.

Use "Identify" to quickly fix incorrectly matched media.

Live TV

If you've got a spare TV tuner knocking about, or an HD HomeRun device plugged into your network, then you can add both live TV and DVR facilities to your Jellyfin server, accessible through any client. You can even extend it to your family on a user-by-user basis via the "Profile" tab of their personal user settings.

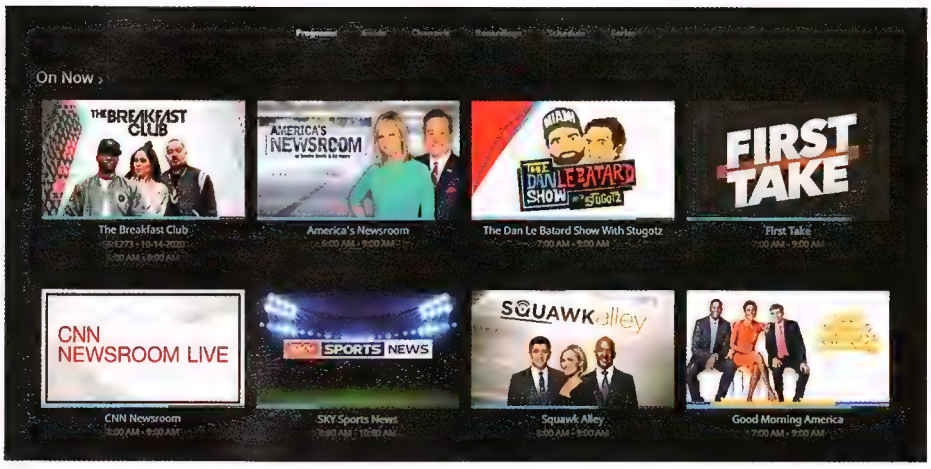
Set it up via the main Dashboard – click "Live TV" on the left and click "+" to add your tuner. HD HomeRun tuners should be detected automatically, while IPTV channel playlists can be added via the M3U option. USB TV tuners require a compatible backend – NextPVR, ServerWMC, or Tvheadend – to be set up, and the appropriate plugin added to Jellyfin (see the plugins box).

Once added, you'll need to assign an EPG (electronic program guide) to allow you to browse and watch live TV, and set up scheduled recordings. Jellyfin supports just two types: Schedules Direct – which only offers program guides for the U.S. and parts of Europe –

and XMLTV – which does include Australian guides. If you can track down a free XML feed, then the latter is the way to go, but it's a convoluted process involving converting online guides to XML files you can plug into Jellyfin, whereas Schedules Direct can be set up and linked within a matter of a few minutes.

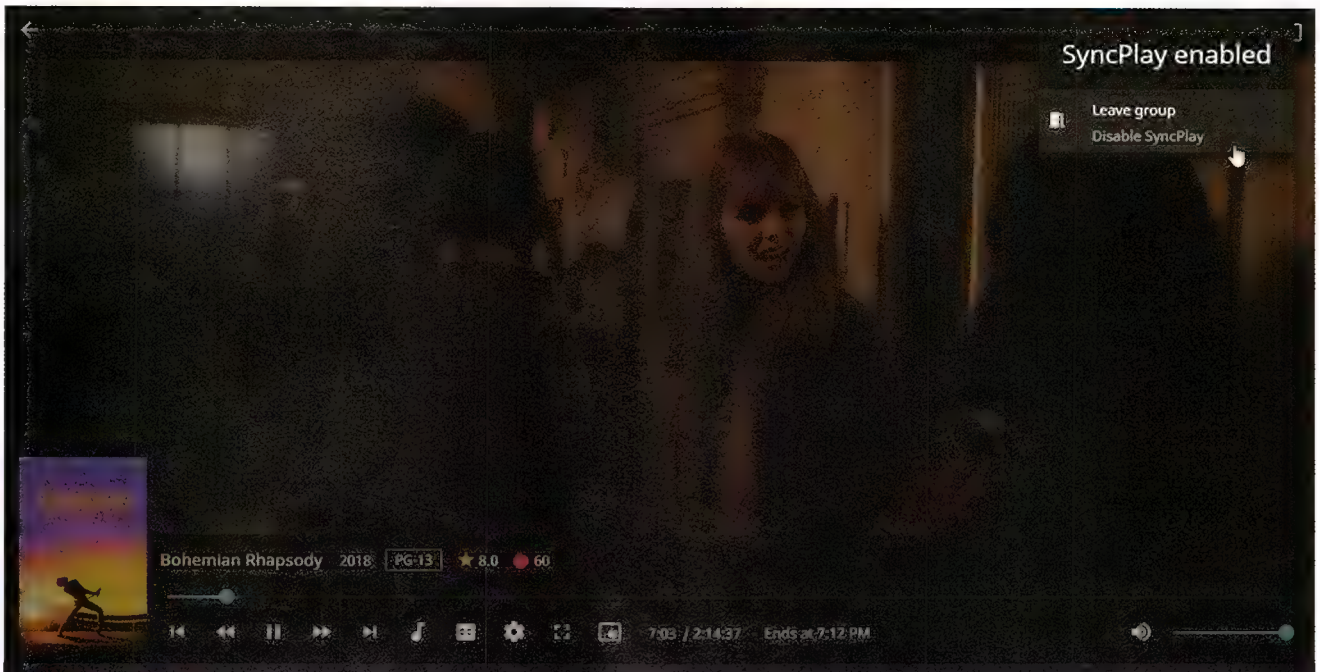
Once done, switch to the DVR section, and specify where to save any TV recordings you make. Note that these will be created as separate "Recorded TV" and "Recorded Movies" libraries in Jellyfin, so try to avoid selecting an existing library folder (or create a dedicated subfolder inside that folder – say \TV\Recorded\) to prevent the new libraries from displaying duplicate information. It's not as elegant as Plex's approach, whereby you can select a specific library to save a recording to, but it's better than nothing. Don't forget to scroll down and click "Save".

Once configured, Live TV will take a prominent spot on your home screen, with a shortcut to its own page, plus an "On Now" section providing convenient shortcuts to shows that are currently broadcasting. When you click on a show, you'll be offered the chance of recording it as well as watching it. When scheduling recordings, you'll see a series link option for a "set and forget" approach; this ensures that all future broadcasts are automatically recorded too.



Live TV guides can be added.

By default, all streams are recorded uncompressed in MPEG2 format. You can manually convert these to MP4/H.264 recordings and then move them into your libraries, or you can make use of a script to perform the conversion. If you're running ffmpeg, Bill Thornton's post-process.sh script (**https://gist.github.com/thornbill**) will do – just invoke it from Jellyfin via the "Recording post processing" option under DVR settings.



SyncPlay

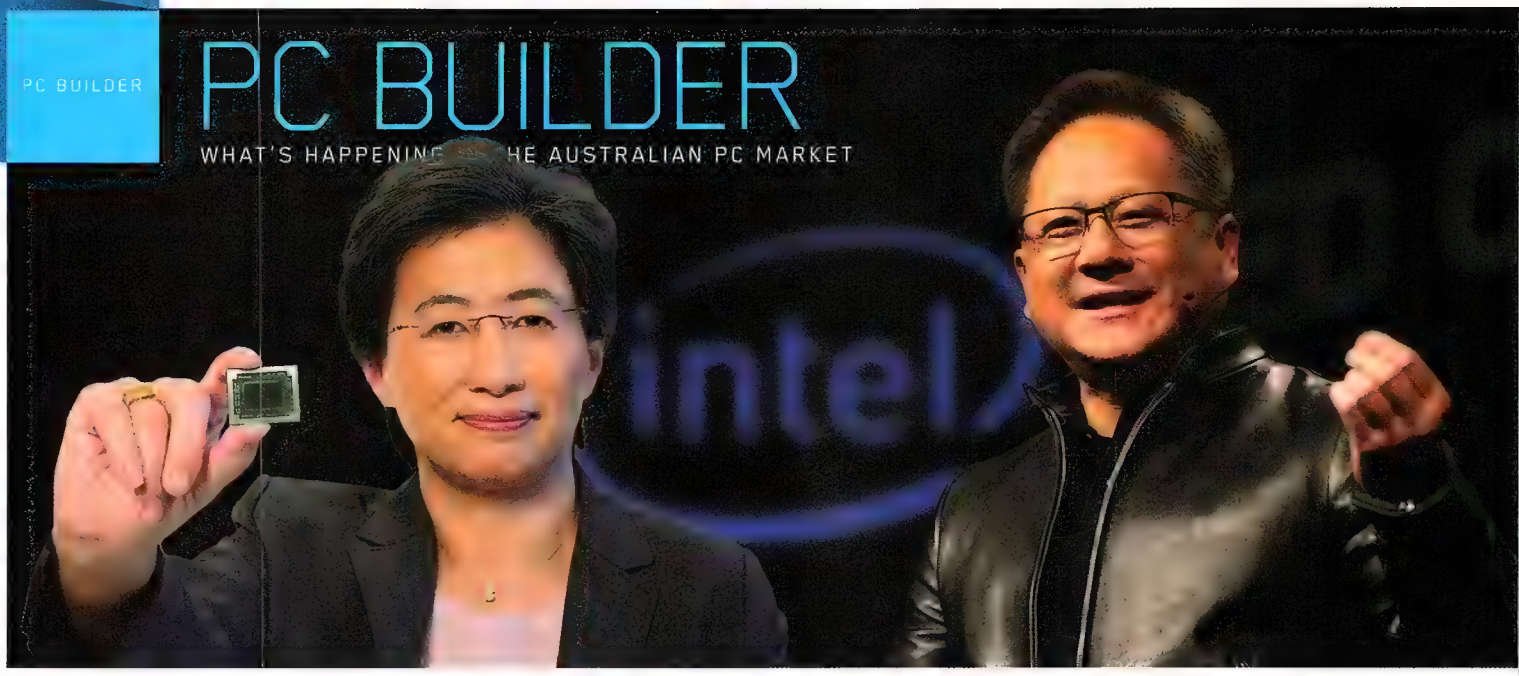
One of lockdown's few pleasures is watching movies together with far-flung family via Zoom. Thanks to Jellyfin's new SyncPlay feature, it's easier than ever to watch the same movie without fiddling about trying to sync up everyone's playback.

The prerequisites are simple: Everyone needs access to your server plus the media library that's serving up the content. Once done, start playback on your main device and look for the "SyncPlay" button (next to "Cast"). Click this and choose "New group."

When your family launch their own instance of Jellyfin and click the "SyncPlay" button, they'll see your movie/episode title appear as a group that they can join. Clicking this should see them join your stream at the same point you're already at. Click play to continue watching. The sync may not be perfect – we had a brief but noticeable lag of about half a second – but unless you can hear each other's stream you should be able to live with it.

PC BUILDER

WHAT'S HAPPENING IN THE AUSTRALIAN PC MARKET



System news

After a hectic year of silicon releases, Mark Williams reflects on 2020 and what to expect in 2021.

MARK WILLIAMS
Mark is an IT professional with a strong interest in voiding warranties.

2020 was quite the year, not just because of the COVID-19 pandemic that spread around the globe, but more interestingly for us was the sheer amount of new PC silicon that was released. I cannot remember a year when so much was released in a single year. It has been quite a ride.

AMD king of the CPU hill once again

2020 started off with the remainder of the Zen 2-based 3000-series line-up launching in the form of the Ryzen 3 3100 and 3300X. The latter of which stirred up great interest in gaming circles with its 4+0 CCX die configuration versus the 2+2 of the 3100. Both had the same core count, but the layout of those cores in the 3300X made quite the difference in benchmarks, so much so it gave us all a hint of what to expect for Zen 3 which basically did away with CCXs.

Intel retaliated with its 10th Gen Core series, notably the i9 10900K and i5 10600K processors, which thanks to Intel's extremely mature 14nm process, are the highest stock clocked parts we've ever seen, at 5.3GHz. These pushed Intel further ahead in gaming circles, holding off AMD's Zen 2 parts handily in the last segment it still retained clear superiority in.

That remained the state of play for a good portion of the year until in November AMD released its 5000-series Ryzen processors, which took out all the performance crowns, even Intel's last remaining hope – best gaming CPU.

Nvidia goes for a knockout but AMD locks horns

In the graphics card scene AMD started the year with its last RDNA1-based GPU launch in the RX 5600XT, which was a solid mid-field contender but ultimately was just a raw price to performance play. It was enough to keep AMD's head in the game, which Nvidia had been dominating for years.

In September Nvidia launched its next gen architecture, Ampere, which finally made a step function improvement in performance over previous 1080Ti/2080Ti GPUs. So far ahead were the RTX 3080 and 3090 that it was hard to see if AMD's upcoming RDNA2 would be able to catch it – particularly since AMD had been absent from the top end of the GPU market for many years. But thanks to the latest gen console development underpinned by RDNA2, the resources put into the console development spilled over into desktop parts.

AMD finally launched its long awaited "Big Navi" cards in November and December and interestingly was able to go toe-to-toe with Nvidia's best once again, returning competition to the high end.

What does 2021 hold for us?

On the CPU front, Intel will be coming out with two hotly anticipated releases that will finally start to put the brakes on AMD's success. First up will be its 11th Gen line-up dubbed "Rocket Lake" using "Cypress Cove" cores, which will be a back port (to 14nm, yet again) of Intel's Sunny Cove mobile architecture. Finally bringing 10 percent or better IPC uplifts in performance to the desktop space, plus PCIe 4.0 support.

After that is "Alder Lake". A more experimental release that sees a 4-big + 4-small core CPU design released. It'll finally bring 10nm parts to the desktop and should make for some interesting benchmarks with four really fast cores and could help Intel once again regain the gaming crown.

AMD is expected to bring out non-X versions of its 5600 and 5800 CPUs, along with lower tier processors down into the Ryzen 3 segment along with an APU refresh.

On the graphics card front, Nvidia is scrambling to release an RTX 3080 Ti and RTX 3070 Ti to cover off AMD's RX 6800/XT cards, and to also refactor the price structure of its line-up which is wholly unsustainable for AIB makers, which aren't making much money off Nvidia cards currently, despite their high prices.

We can also expect to eventually see mid-range card releases from both, down into the entry level to flesh out the rest of the product stacks. It'll be interesting to see if Nvidia kill off GTX in the low end, making its whole product stack RTX.

One thing AMD needs to execute on soon is its answer to DLSS. Dubbing its version "Super Resolution" AMD is starting to lag in the features department with its cards. While it can be forgiven for having worse ray tracing performance given that it's AMD's first attempt, lack of a DLSS alternative is hurting it in scenarios where DLSS is saving Nvidia cards from poor ray tracing performance. AMD is working on it and should bring out something in 2021, let's hope it's good enough to keep competition going.

Market snapshot

An overview of typical systems in today's market.

$1,749 | tinyurl.com/APC490UMK

Umklogix M-Power Ryzen 3100 GTX1650

This system may look nice in all its MSI branded garb, but inside is something of pricey dog's breakfast of parts.

The processor is a bottom of the rung Ryzen. While the cheapest entry point into the platform, it will be a bottleneck even with the lower end dedicated graphics card which, for this system's price I'd be expecting to see a GTX 1660/ Super. The 1650 Super is a little disappointing and affects the value of this system. The motherboard is over the top for this build, a B450 solution would've been more appropriate. Likewise, the PSU is a top tier model for no real reason other than the matching MSI branding. The less-than-ideal memory speeds and completely unnecessary 3rd party CPU cooler make this an overpriced mess to avoid.

CPU: AMD Ryzen 3 3100, **Cooler:** MSI Core Frozr S, **M/board:** MSI B550M Pro-VDH WIFI, **Graphics:** MSI GeForce GTX 1650 Super Ventus XS OC 4GB, **Memory:** 16GB DDR4 3200MHz, **Storage:** 512GB M.2 NVMe SSD, 1TB HDD, **Power Supply:** MSI MPG A650GF 650W, **Case:** MSI MAG Forge 100R

$3,199 | tinyurl.com/APC490PLE

PLE Computers Coal Prebuilt

This one's set up for overclocking with its unlocked i7 10700KF and a spiffy 240 AIO watercooler that shows CPU temperatures on the water block housing, along with a nice case with plenty of ventilation and a GPU to turn all those clock cycles into lots of 1440p FPS. The only trouble is that the motherboard's H470 chipset is incapable of overclocking (thanks Intel). So while the fancy cooling and CPU are nice, ultimately they're rather wasted here. It'd be worth asking PLE if they can upgrade you to a Z490 motherboard to unlock this system's full potential. The rest of the system looks to be very solid and worthy of the price and performance needs of this build.

CPU: Intel Core i7 10700KF, **Cooler:** Gigabyte Aorus RGB 240 AIO, **M/board:** Gigabyte H470 Aorus Pro AX, **Graphics:** Gigabyte RTX 3070 Gaming OC 8GB, **Memory:** 16GB Gigabyte brand DDR4, **Storage:** Samsung 970 Evo Plus 500GB NVME SSD, **PSU:** Not specified, **Case:** Corsair Carbide 275R Tempered glass edition

$3,499 | tinyurl.com/APC490AUC

Austin Computers Thermaltake Frostbyte Pro

This showpiece is quite the eye catcher. Looking like an anime transformer, this system packs solid mid-tier performance parts. The 3700X is great for high detail gaming and not the best if you're after the highest FPS results, if you prefer to turn up all game details and resolutions at the cost of FPS then this'll be fine and being 8-core will afford you some extra grunt when you need it for productivity. The RTX 3070 will give you good range of gaming options including ray tracing at 1440p and even 4K gaming. The 32GB of RAM is particularly nice for more demanding users and running at 3600MHz it is perfect. Storage is adequate and the PSU has plenty of overhead for future upgrades.

CPU: AMD Ryzen 7 3700X, **Cooler:** Thermaltake TH240 AIO, **M/board:** Asus TUF Gaming B550M-Plus Wifi, **Graphics:** Asus GeForce RTX 3070 Dual 8GB, **Memory:** 32GB Thermaltake ToughRAM RGB 3600MHz White Edition, **Storage:** 500GB M.2, 2TB HDD, **PSU:** Thermaltake Toughpower Grand 750W, **Case:** Thermaltake AH T200 Snow

$3,899 - tinyurl.com/APC490SCO

Scorptec Eridium RTX 3080

Coming in $400 more than the Austin Computers PC, this nets you a few extras that might be of interest. While the CPU remains the same, the cooling is pushed up to a 360mm AIO for more efficiency. The motherboard moves up to an X570 chipset which will give more IO expansion options, mostly in the PCIe department. Importantly the GPU gets bumped up to an RTX 3080 which will easily push along any 4K, or multiple 1440p/ultra-wide screen setups. Annoyingly the RAM drops down relatively to 3200MHz sticks, not the end of the world but it's lost performance left on the floor. Finally, the SSD moves up to 1TB in capacity and a chassis that has more mainstream sensibilities.

CPU: AMD Ryzen 7 3700X, **Cooler:** Corsair Hydro H150i RGB Pro XT CPU Cooler, **M/board:** Asus TUF X570-Plus WIFI Motherboard, **Graphics:** Asus TUF GeForce RTX 3080 10GB, **Memory:** Corsair Vengeance RGB Pro 32GB 3200MHz DDR4, **Storage:** Samsung 970 EVO Plus 1TB M.2 SSD, Seagate, BarraCuda 2TB HDD, **PSU:** Corsair RM750 750W, **Case:** Corsair iCue 465X RGB

BLUEPRINTS

VALUE- AND PERFORMANCE-DRIVEN HYPOTHETICAL BUILDS

PC BUILDER

Budget

Competent.

There's a huge demand for new products that's far outstripping the supply, and on top of that, because of Black Friday prices have annoyingly crept up across the vast multitude of PC parts in the leadup, as retailers then decrease the price to simulate a sale-like atmosphere, and following that is another price rise back to 'normal'. This is one of the big reasons why we always recommend going to a site like *PC Gamer* or *TechRadar* when it comes to sourcing good deals. These boys and girls do the legwork for you, to hopefully sift the wheat from the chaff, so to speak.

Thankfully we were able to keep the overall price increase to around $30 on both systems, and without significantly changing the components. Still, concessions were made. We've had to drop to a 250GB Samsung 980 Pro in the AMD build, down from the 500GB we featured last issue. Our Intel machine has also seen some change, with us going for the positively old 500GB Samsung 970 Evo M.2 PCIe 3.0 SSD (still a darn quick drive), and changing to the Core i5-10400F as well, which lacks integrated graphics. Just be wary: If you do plan to build this rig without the graphics card, you will need to opt for the standard Core i5-10400 instead, or rummage around your spare parts bin for a GPU.

"Because of Black Friday prices have annoyingly crept up across the vast multitude of PC parts in the leadup, as retailers then decrease the price to simulate a sale-like atmosphere, and following that is another price rise back to 'normal'."

AMD INGREDIENTS

PART		PRICE
CASE	CORSAIR 4000D AIRFLOW	$129
PSU	450W GIGABYTE GP-450B 80+ BRONZE	$69
M/BOARD	ASROCK B550M PRO4	$169
CPU	AMD RYZEN 3 3100	$169
GPU	XFX RADEON RX 5500 XT 4GB	$285
RAM	16GB (2 X 8GB) G.SKILL RIPJAWS V SERIES @ 3,600MHZ	$129
SSD	250GB SAMSUNG 980 PRO M.2 PCIE 4.0 **NEW**	$135
HDD	1TB SEAGATE BARRACUDA HDD	$65
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		$1,210

INTEL INGREDIENTS

PART		PRICE
CASE	CORSAIR 4000D AIRFLOW	$129
PSU	450W GIGABYTE GP-450B 80+ BRONZE	$69
M/BOARD	ASROCK B460M PRO4	$135
CPU	INTEL CORE I5-10400F **NEW**	$229
GPU	MSI GEFORCE GTX 1650 SUPER VENTUS XS OC 4GB	$239
RAM	16GB (2 X 8GB) TEAMGROUP T-FORCE DARK Z @ 3,200MHZ	$109
SSD	500GB SAMSUNG 970 EVO M.2 PCIE 3.0 **NEW**	$99
HDD	1TB SEAGATE BARRACUDA HDD	$65
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		$1,134

PC BUILDER

Mid-range

Decent.

And here is where things start to get tricky, and this is mostly down to the all the newly released hardware out there. Unfortunately, although AMD's Ryzen 5 series and Radeon RX 6000-series cards, and Nvidia's 3000-series cards are impressive products, there just isn't any of them out there. Demand has far outstripped supply. We're still hearing rumours that Nvidia isn't expecting supplies to keep up with demand until spring 2021. And it looks to be the same for AMD too, both for its Ryzen chips and its GPUs. That's crazy – at any other time we'd call all of these paper launches, but it seems that there's just so much demand because of the pandemic that it might not even be the case.

We're starting to see the end of supply for the older series parts too, including 2000-series cards from Nvidia, 5000-series GPUs from AMD, and Ryzen parts. This is a serious issue, because if you actually want to buy a graphics card in Australia right now, you sort of can't get one – not from the usual retailers, Amazon, or anywhere. You'll only really find these cards on eBay or Amazon at super-inflated prices from dubious third parties or scalpers. Yay.

To that end changes here are fairly subtle. We've swapped out the Corsair A500 air cooler in our Intel rig for a Cooler Master Masterliquid ML240L. The A500 had gone up in price and considering this is a 240mm AIO, the choice was obvious. On top of that we've also gone from our MSI Radeon RX 5700 Mech 8GB to a GeForce GTX 1660 Ti 6GB instead.

For our AMD rig we've had to opt for the stock Ryzen 5 3600 to save a bit of cash, and grabbed another 5700.

AMD INGREDIENTS

PART		PRICE
CASE	LIAN LI PC011-DYNAMIC	$229
PSU	650W CORSAIR CX650	$135
M/BOARD	ASUS TUF GAMING X570-PLUS	$349
CPU	AMD RYZEN 5 3600 **NEW**	$339
COOLER	CORSAIR A500	$159
GPU	MSI RADEON RX 5700 GAMING X 8GB **NEW**	$669
RAM	16GB (2 X 8GB) G.SKILL RIPJAWS V SERIES @ 3,600MHZ **NEW**	$139
SSD	500GB GIGABYTE AORUS GEN4 M.2 PCIE 4.0	$169
HDD	1TB SEAGATE BARRACUDA HDD	$65
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$2,313**

INTEL INGREDIENTS

PART		PRICE
CASE	LIAN LI PC011-DYNAMIC	$229
PSU	650W COOLER MASTER MASTERWATT 650	$109
M/BOARD	MSI MPG Z490 GAMING PLUS	$299
CPU	INTEL CORE I7-10700	$499
COOLER	COOLER MASTER MASTERLIQUID ML240L AIO **NEW**	$99
GPU	MSI GEFORCE GTX 1660 TI 6GB VENTUS XS OC **NEW**	$429
RAM	16GB (2 X 8GB) TEAM T-FORCE DELTA RGB @ 3200MHZ	$130
SSD	500GB WD BLACK SN750 M.2 PCIE 3.0	$118
HDD	1TB SEAGATE BARRACUDA HDD	$65
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$2,037**

PC BUILDER

Turbo

Stupendous.

Sadly this trend continues in our Turbo builds, once again because of a lack of supply, and for the first time in the history of this segment, we have no alternative solution to our graphics card woes. If you want a high-end GPU right now, whether that's one of the brand-new ones from AMD and Nvidia, or the last generation's, there simply isn't any. The best you can do is find somewhere that will let you pre-order the card you want, but in all honesty, you'll likely be stuck in a queue for a considerable length of time.

The Gigabyte GeForce RTX 3080 Eagle is our card of choice for the time being because it's so competitively priced. There is some justification for going with an AMD Radeon RX 6800XT for the Ryzen system due to their shared memory capabilities, but you really shouldn't purchase one for more than the going retail price. The more we encourage scalping as a community, the worse it will become.

Outside of the shortages, we've been able to make a few changes. For our AMD system we've replaced the ageing 280mm iCUE H115i from Corsair with its latest Capellix-powered 360mm. This should keep your processor cool, whether that's the 3950X that you can still purchase, or the AMD Ryzen 9 5950X we'd recommend in its stead.

For our Intel system we've gone for a fancier Gigabyte Aorus motherboard, upgraded again to a 360mm AIO for our overclockable chip, and swapped out that old 6TB Seagate HDD (that's no longer available) for a Western Digital Red Pro. Although typically designed for use in NASes, the extra reliability will help long-term, and 6TB of storage is more than enough for your media.

As an alternative, you could opt to go for a dedicated NAS instead; Asustor sells a fantastic two-bay NAS (the AS5202T) for $550, which even comes with twin 2.5GbE Ethernet ports, making it ideal for backing up all of your personal media collections.

AMD INGREDIENTS

PART		PRICE
CASE	PHANTEKS ENTHOO PRO 2 TEMPERED GLASS	$219
PSU	750W CORSAIR RM750X MODULAR PSU	$199
M/BOARD	MSI MPG X570 GAMING WIFI	$309
CPU	AMD RYZEN 9 3950X	$1,100
COOLER	CORSAIR ICUE H150I ELITE CAPELLIX 360MM AIO **NEW**	$299
GPU	GIGABYTE GEFORCE RTX 3080 EAGLE 10G	$1,399
RAM	32GB (2 X 16GB) CORSAIR VENGEANCE RGB PRO @ 3600MHZ	$250
SSD	1TB GIGABYTE AORUS GEN4 M.2 PCIE 4.0 **NEW**	$269
HDD	6TB WESTERN DIGITAL RED PRO HDD **NEW**	$359
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		$4,463

INTEL INGREDIENTS

PART		PRICE
CASE	PHANTEKS ENTHOO PRO 2 TEMPERED GLASS	$219
PSU	850W NZXT C850	$199
M/BOARD	GIGABYTE Z490 AORUS ULTRA ATX **NEW**	$469
CPU	INTEL CORE I9-10900K	$800
COOLER	NZXT KRAKEN X73 360MM **NEW**	$299
GPU	GIGABYTE GEFORCE RTX 3080 EAGLE 10G	$1,399
RAM	32GB (2 X 16GB) CORSAIR VENGEANCE RGB PRO @ 3600MHZ	$250
SSD	1TB WD BLACK SN750 M.2 PCIE 3.0	$195
HDD	6TB WESTERN DIGITAL RED PRO HDD **NEW**	$359
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		$4,169

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BUILD 01

Office Hours

Working from home? Here's our straightforward guide to building a solid office PC.

The home-working revolution might've been a brief bump in the professional road for some of our readers, but many of you might find yourselves settling in for the home office long-haul. Many are simply looking to split their time between the office and home. Either way, there's something to be said for the humble home office PCs across the nation, many of which will probably be getting their first major workout in years.

If you've got an ageing work computer at home, perhaps a chunky Intel-branded tower from 2008 or a laptop that needs to be plugged in constantly, it's time for an upgrade. This issue, we're going to be breaking down the specifics of what makes a good home-working PC, then going through the build process in detail so even the rookie builders out there can follow the process.

First of all, it's got to be affordable. It's one thing to drop $5,000 on a powerhouse gaming rig or 4K video-editing workstation, but if all you want to do with your PC is office work and the odd bit of Netflix streaming, then there's no need to break the bank. We're aiming for a target price in the realm of $1,000 here, although we targeted that before all the components had been finalised, so forgive us if we ruin that in a few pages.

We're talking integrated graphics rather than a dedicated GPU, a sensibly priced motherboard, and a low-wattage power supply with leeway for future system expansions. We're not going to dabble in RGB or flashy cooling solutions – it's air cooling only here.

Secondly, and just as importantly, this PC needs to be competent at the broad range of office work we're going to throw at it. Sure, none of it's going to be extremely demanding, but we're talking about everything from simple word processing to giant spreadsheets and lightweight graphic-design work. So we'll need a mid-range processor with enough memory to perform at full potential

We won't be slapping a big drive in this either; cloud-based storage is generally a better option for anyone who doesn't need to handle massive media files in the nine-to-five. That said, we won't completely skimp on storage.

The competition here is fierce. Pre-built compact work desktops and all-in-one solutions are common and generally not too expensive, so we need to stay on budget. Later on, we'll break down options for cutting the price down further, as well as upgrading. If our mission is successful, we should have a home office PC that will last for years to come.

"We won't be slapping a big drive in this either; cloud-based storage is generally a better option for anyone who doesn't need to handle massive media files in the nine-to-five."

INGREDIENTS

PART		PRICE
CASE	LIAN LI LANCOOL II	$169
M/BOARD	ASUS PRIME B460M-A	$139
CPU	INTEL CORE I3-10100	$179
COOLER	CORSAIR A500	$139
MEMORY	8GB (2 X 4GB) HYPERX SAVAGE DDR4-3000	$60
PSU	450W CORSAIR CX450	$94
BOOT DRIVE	SAMSUNG 860 EVO 500GB	$88
OS	WINDOWS 10 HOME OEM	$60
TOTAL		$928

prices correct at time of printing.

The hardware

MOTHERBOARD

Asus Prime B460M-A

$139

The B460 chipset is the ol' reliable of Intel motherboards, and the Asus Prime B460M-A is a cheap motherboard solution that has all the features we'll require, without any costly bells and whistles. We don't need RGB lighting or USB-C support here, just solid performance and a simple layout that will be straightforward enough for rookie PC-builders to work with. The UEFI BIOS is easy to navigate, and Asus's proprietary OptiMem technology helps to improve RAM stability and performance without needing any user input. The rear I/O packs both HDMI and DisplayPort support for our integrated graphics to output video.

CPU

Intel Core i3-10100

$179

The Core i3-10100 is the archetypal budget CPU from the current Intel generation, bringing four cores and eight threads to the party, along with Intel's solid UHD Graphics 630. It's certainly a modest offering compared to some of the powerhouse CPUs and GPUs we love to look at in *APC*, but for a professional system that needs reliability and efficiency, it's an excellent choice. Intel Turbo Boost technology gives this chip an impressive max boost clock of 4.3GHz, and while those integrated graphics won't be able to handle much in the way of gaming, for streaming video at resolutions up to 4K it should be able to manage just fine.

CPU COOLER

Corsair A500

$139

It's a lot of money to spend on a cooler, sure, and the Core i3-10100 does come with a stock Intel cooler, so if you're looking to lop some cash off this build then the aftermarket cooler should be the first thing to go. But Intel's stock coolers are pretty mediocre, and given that the 10100 will be handling both CPU and iGPU tasks, we've decided that a beefier cooler will allow for lower operating temperatures and some overclocking headroom. The A500 is a twin-fan beast, one of the biggest air coolers we've seen, so it fits the bill perfectly.

SSD

500GB Samsung 860 Evo

$69

Samsung's SSDs are still among the best in the business – even the older models like the 860 Evo. Half a terabyte of SATA III storage for under 100 dollars was unheard of just a few short years ago, but the 860 Evo is cheaper than ever now, bringing 3D NAND and 500MB/s+ transfer speeds to your PC without breaking the bank. The more SSD technology advances, the cheaper older SSDs become. Given the gap in performance, we imagine it won't be that long before HDDs are rendered entirely obsolete, beyond budget long-term storage uses such as mass data backups and home NAS systems.

PSU

450W Corsair CX450 80+ Bronze

$94

There's no need for a fancy modular power supply here, nor a high wattage. 450W is more than sufficient for this build (our processor's TDP is only rated at 65W, for example) and will allow for some expansion later on if required. Corsair is a trusted brand when it comes to power supplies, and the 80+ Bronze certification guarantees decent energy efficiency for this build. The CX450 is good value at $94: Not the cheapest 450W PSU around, but we'd advise against selecting super-budget manufacturers when it comes to your power supply. If you buy new, the CX450 comes with a five-year warranty from Corsair, covering you for component failure.

RAM

HyperX Savage or Vengeance 8GB (2 x 4 GB) DDR4-3000

$60

With memory prices falling significantly over the last couple of years, 8GB should be considered the new baseline for any system. If you're looking to do anything more demanding than bog-standard office tasks, such as gaming or video editing, 16GB will often be a better option. Higher speeds of DDR4 RAM are also becoming the norm, with 2,400MHz kits costing fairly similar to their speedier contemporaries. As such, we've chosen a simple dual-channel 8GB kit at 3,000Hz from HyperX, which should be plenty for the sort of work this system is designed to do. Upgrading the memory later on is always an option, of course.

CASE

Lian Li Lancool II

$169

We have a confession to make: The Lancool II wasn't our first-choice case for this build. When time constraints and deadlines loom, we sometimes have to make quick decisions to get our builds out to your eyeballs on time. You might've been able to figure this out from our choice of motherboard, as this is a chunky ATX mid-tower rather than the more compact mATX case we were hoping to secure. It's still an excellent choice, with a durable metal and glass construction and plenty of space for cable routing and drive mounting. Should you wish to expand storage later, the Lancool II's got you covered.

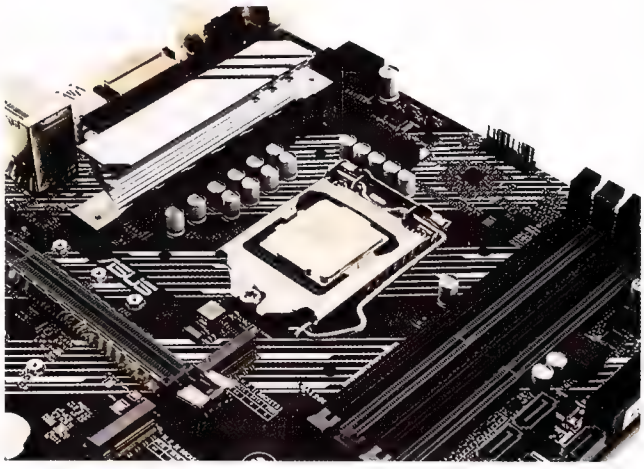
Getting Down To Business

With no unusual features and no graphics card, this is a build that even a novice should be able to complete. Clear some space, gather your components, and let's get to work.

Length of time: 1-2 hours. Level of difficulty: easy

01 OPEN SESAME

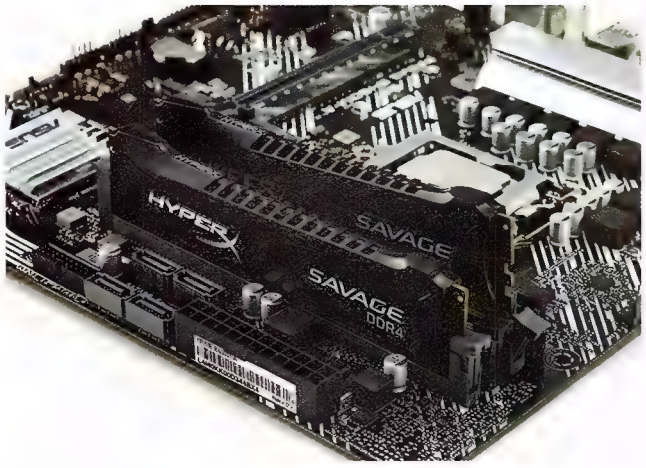
The Lian Li Lancool II's two tempered-glass panels are hinged at the rear but offer no visible handle or push-pins to open them. Instead it has two "wings'" forming the sides of the PSU shroud, which secure magnetically and are hinged at the base of the case. Open both of these using the small handles at the back of the case, swing open the glass side panels, and carefully lift them off their hinges. Replace them in the case box. Don't worry about removing the front panel as we're not changing the pre-installed fan at the front, but remove the magnetic dust filter on the top. Finally, remove the two black metal cable shrouds on the rear of the motherboard plate. These come off with a single thumbscrew each; set them aside for later.



02 PROCESSOR PROBLEMS

The CPU sockets on Intel motherboards are less beginner-friendly than their AMD equivalents, but the CPU is still one of the easiest components to install. To open up the bracket, depress and release the metal retention arm from the clasp to the side of the socket, then lift it up so that the metal "teeth" at the end of the socket slide out from underneath the fixed screw and the entire bracket rises up. Drop the processor into the socket, lining it up correctly, then lower the bracket back into position, locking the teeth under the screw and pushing the retention arm back down beneath the clasp.

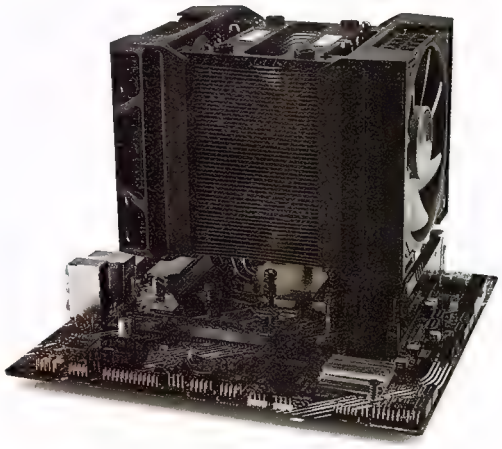
If your motherboard is new, it will have a plastic cover affixed to the top of the bracket. It'll pop off once you re-secure the bracket.



03 MEMORY MOUNTING

RAM installation shouldn't be too complicated. There are two sticks but four DIMM slots. Thankfully, the motherboard has labels printed on it to indicate which slots will be prioritised by the finished system – slots A2 and B2 here; that's the second and fourth slots away from the CPU socket. These DIMMs only have clasps on one end, so release these and then lower each stick of memory into place, lining it up then pushing it down at both ends so it clicks into place and the clasp snaps shut.

Be gentle when positioning the memory in each slot; the silicon undersides of the sticks can be delicate. Memory upgrades might prove a bit bothersome, as the cooler we're going to install will obstruct access to the DIMM slots.



04 DOUBLE TROUBLE

Since this twin-fan offering from Corsair can be used with different CPU sockets, it comes with its own proprietary mounting solution. Open up the Intel 115x plastic bag for the parts. Fit the large bracket to the underside of the motherboard, so it lines up with the four holes around the CPU. Screw in the four 115x standoffs, then fit the two mounting brackets to those using the provided thumbscrews. Remove the pop-off top panel of the cooler block and free the two fan power cables, then fit the cooler over the CPU (mind your fingers on the thermal paste), and secure the two sprung screws using the included long screwdriver. Replace the top panel, and plug the cables into the CPU_FAN and CPU_OPT headers on the board.

Make it cheaper

We went a bit over budget for this build, but don't worry, there are always ways to trim down the price on any custom-built PC.

Our first target here would be the case. As we mentioned earlier, the Lancool II – while great – wasn't our initial choice. A budget mATX case from the likes of Cooler Master or Corsair, without any RGB lighting or tempered glass, shouldn't cost more than $100. Sure, it won't look as nice as the PC we've built here, but if it's going to be hidden beneath a desk then it hardly matters.

Cutting back on our cooling solution is also an option here, as the Corsair A500 is a relatively expensive air cooler. Using the stock Intel cooler that comes with your processor is always an option, although plenty of budget aftermarket coolers are available for between $40-$80, and these will almost certainly offer better thermal performance. You may also be able to save a small amount of cash by switching out the SSD to a more affordable brand such as Adata or Kingston, and an MSI or Asrock B460 motherboard should let you shave off a few extra dollars.

As always, be wary of brands you haven't heard of when it comes to buying PC components. If a deal seems too good to be true, do a bit of research to find out what people think about the manufacturer in question. Cheap knock-offs are common, and while some budget brands (like PowerColor, ARCTIC, or Rosewill) are generally OK, there are some components that you shouldn't compromise on. When it comes to drives and power supplies, it's best to stick with the household name brands; not only does this ensure quality and longevity, but manufacturers like Corsair and EVGA offer lengthy warranties, should anything go awry.

The Cooler Master N200 doesn't look like much, but it's a straightforward and effective PC case for just $80.

05 BOARD STIFF

It's time to fit that motherboard! You'll need to move some of the standoffs in the Lancool II, since they're likely to come laid out for a standard ATX motherboard rather and an mATX model like the B460M-A. Using an adjustable wrench, loosen the required standoffs and reposition them so that they'll line up with the holes around the edges of the board. Then, place the case on its side and carefully lower the mobo into it, mounting it on the central mounting peg before ensuring that all the standoffs are lined up correctly. When you're confident, use a Phillips-head screwdriver to secure the motherboard at the six mounting points – use a long magnetic screwdriver for this. Also, remove the case fan in the roof of the case by removing its four screws.

06 CLEAR YOUR PLATE

The SSD mounting plate can be found behind the motherboard, secured by a lone thumbscrew. Remove it, and use four of the same screws used to mount the motherboard to affix the Samsung 860 Evo to this slip of metal. Make sure the drive will be pointing downwards once it's returned to the case; when you re-mount the plate and secure it with the thumbscrew, you'll need to connect it to the motherboard using a SATA cable (included in the motherboard box). Given the upright-facing SATA ports on the motherboard, use the cable that has a perpendicular connector on one end, allowing you to more easily bend the cable around and plug it into the motherboard. It doesn't matter which of the SATA ports you use here.

Make it better

If you like the look of this system but feel that it's not quite up to the work you want to do, there are improvements to be made.

The obvious addition is a dedicated graphics card, which you may want if you need your system to be capable of any 3D-rendering tasks. Bear in mind that without upgrading the PSU and CPU, this system can only support a relatively conservative GPU. An Nvidia GTX 1650 or AMD RX 560 would both be a good fit, for around $250.

If you're not looking for improved graphical oomph, you may want to investigate the potential of a more powerful processor. The Core i3-10300 clocks a little higher than our chosen chip and also has slightly more cache memory, but if you want to see a real improvement then jumping up to the hexa-core i5-10400 or i5-10500 is a better choice. It's worth noting that all of these chips have the same UHD 630 integrated graphics; if you really want better performance from your iGPU, you will need to jump ship to the Ryzen 5 3400G and its excellent RX Vega 11 integrated graphics.

Elsewhere, there are more straightforward upgrades that can be made. If you're the sort who likes to keep dozens of Chrome tabs open at once, upgrading from 8GB to 16GB of RAM might be a worthwhile (and not too costly) adjustment. The Lancool II case has ample room for additional hard drives, and the Asus Prime B460M-A has two M.2 slots for super-speedy SSDs if you need fast file transfers in your day-to-day work. Lastly, although we always recommend connecting your system to the internet via a wired connection, if you're going to need Wi-Fi capabilities for your machine you'll need to select a motherboard with wireless support.

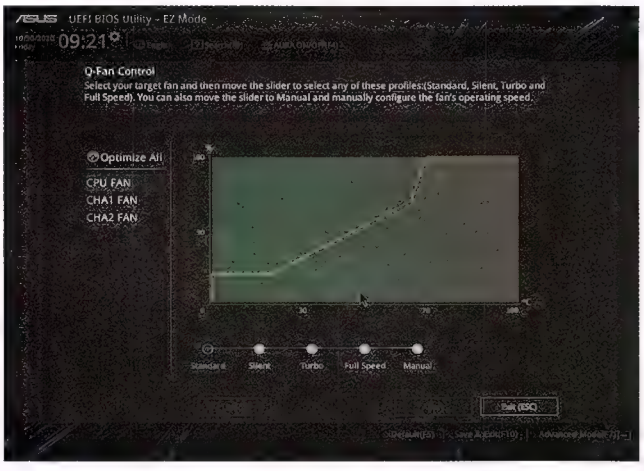
PNY sells a factory-overclocked single-fan GTX 1650 for just $235, which could boost this system's performance significantly.

"The obvious addition is a dedicated graphics card, which you may want if you need your system to be capable of any 3D-rendering tasks. Bear in mind that without upgrading the PSU and CPU, this system can only support a relatively conservative GPU."

07 POWER HOUSE

Before installing the power supply, tuck the front I/O cables out of the way towards the front of the case. You're not going to need all the cables provided, but the non-modular design means there's no way to remove them. You'll need a 24-pin ATX power cable, an eight-pin CPU power cable, and a multi-connector accessory cable. Bundle the rest with cable ties.

Install the power supply at the rear of the case, with the fan pointing downwards, then screw it into place with four of the PSU screws. Route through and plug in the two larger power cables to the connectors on the motherboard, and connect the accessory power cable to the SSD and lighting strip from the front I/O cable bundle. Make sure the clasps on the motherboard power cables click into place.


UEFI BIOS Utility - EZ Mode
09:21
Q-Fan Control
Select your target fan and then move the slider to select any of these profiles:(Standard, Silent, Turbo and Full Speed). You can also move the slider to Manual and manually configure the fan's operating speed.
Optimize All
CPU FAN
CHA1 FAN
CHA2 FAN
Standard
Silent
Turbo
Full Speed
Manual

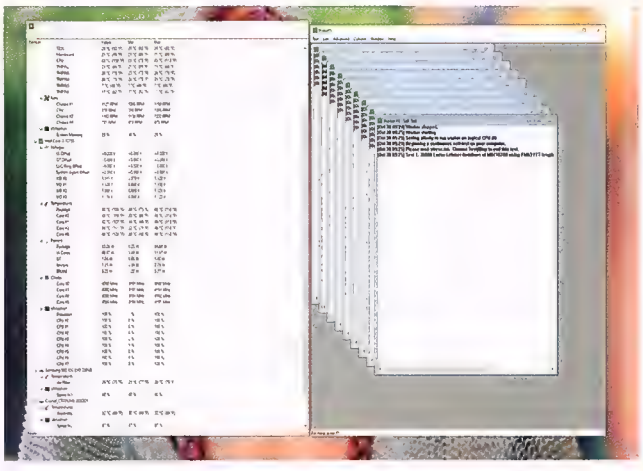
09 BIOS BOTHER

As is often the case with modern RAM kits, you're going to need to take a trip into the BIOS to get the most out of your memory. Fortunately, the Asus Prime B460M-A has a nice, streamlined UEFI BIOS. All you need to do to improve memory performance is slap the XMP to "enabled" in the EZ Mode version of the BIOS, and you'll reap the benefits of the full speed supported by the motherboard and processor. You can also tweak the system fan curves. Since we've got a powerful air cooler, and the Core i3-10100 runs relatively cool anyway, adjusting the fan curves for lower speeds when idling or during non-intensive tasks will allow for a quieter running system. If you add additional drives later on, come back to the BIOS and adjust the boot priority so you're still booting from the 860 Evo.

08 SHROUDED IN SECRECY

There's no appropriate RGB header on the motherboard for the Lancool II's lighting, but it isn't necessary anyway on this build. Connect the two remaining fan cables, USB feedthrough, HD audio, and front I/O controls to the relevant headers on the motherboard. These are all clearly labeled, but if you have any difficulty, consult the motherboard manual.

Bundle your cables together using the Velcro straps and cable ties, but don't worry if cable management isn't your forte: Remember those two large shrouds we removed? Return those to the case once your cables are all plugged in, concealing all your cables. With that done, return the side panels and close this case up – build complete! But we're not quite done yet…



10 SOFTWARE SORTED

you'll need to install Windows here, but that process is fully guided in-OS. Instead we'll provide some software recommendations to help everything run smoothly. CPUID offers two handy programs, CPU-Z and HWMonitor. The former lets you check that your components are functioning properly, while the latter is a simple system-monitoring tool.

To stress-test your machine, download Prime95 for free. Use this in conjunction with HWMonitor to perform a blended function "torture test" on the CPU, which will push the chip to its thermal limits. HWMonitor keeps track of max temps, so leave Prime95 running for a few minutes then check it. Your CPU temps shouldn't rise higher than 50C with this cooler; if the chip gets too hot, check your fans are connected and functioning.

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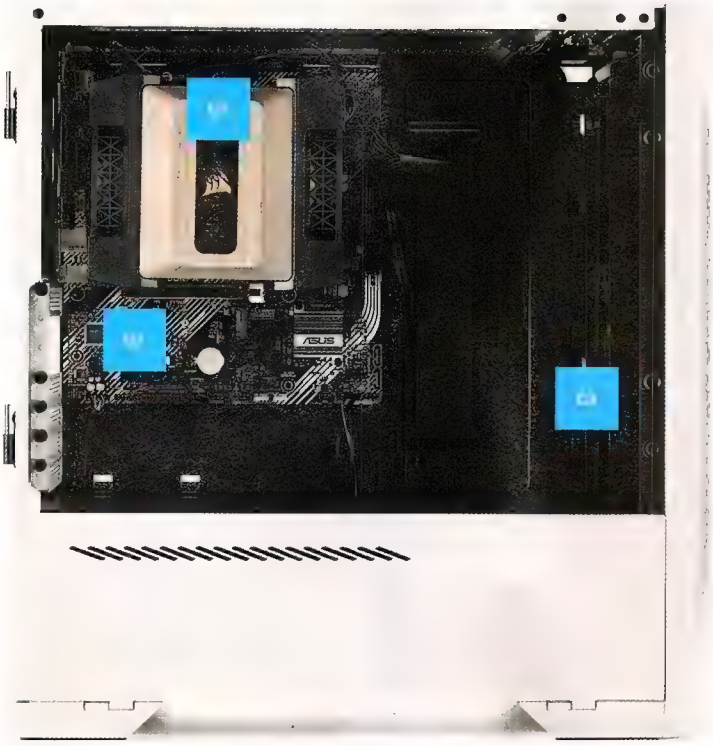


01
The Corsair A500 is a seriously bulky cooler, but it performs admirably even under duress, and is definitely quieter than an AIO cooler.

02
Adding a dedicated GPU to this machine would be a simple proposition, especially a cheaper model that doesn't require a dedicated power cable.

03
The metal "wings" and tempered-glass panels of the Lancool II are held in place by tiny but surprisingly powerful magnets.

Function over form

It ain't exciting, but it works well. We're impressed with the overall performance of the Intel Core i3-10100, as it handled 4K display output with zero issues. As suspected, serious gaming isn't really an option here, but 2D indie titles should be able to run on this system if you're ever in the mood for a little bit of light puzzling or a visual novel experience. Those UHD 630 integrated graphics have been around for years, so we didn't really expect much.

CPU-bound performance was quite good. Our testing demonstrated a two-thirds performance increase on average against the Core i3-8100, with a slightly smaller generational leap between the 10100 and the 9100 it supersedes. Single-core performance hasn't improved that much between the generations, although the i3-10100 is the first Core i3 X100-spec budget Intel Core processor to utilise Hyper-Threading, which boosts performance in multi-threaded workloads.

Our Samsung SSD might be almost three years old now, but it still pushes the limits of what the SATA III format is capable of. Upload and download speeds both sit close to the 550MB/s figure, which is generally the fastest transfer speed you're going to get from a 2.5-inch drive. While SATA III connections are capable of 600MB/s, you won't hit these speeds due to system overheads. A cheaper SSD might've been worthwhile, as the difference would've likely been negligible, but the Samsung drive is a reliable choice.

This machine outperformed our integrated graphics zero-point system. We do think that there's some money to be saved here, and Intel Graphics UHD 630 definitely isn't up to snuff when compared to its RX Vega competitors, but we can't complain. Dual-monitor support is an option (although twin 4K monitors might cause the iGPU to struggle), and we don't think we'd be able to squeeze much more performance from this rig without significantly increasing the price. A quad-core chip is sufficient for our needs here.

When it comes to overclocking, we're happy with our choice of components. Intel Turbo Boost is good, allowing for effortless "auto-overclocking" of the i3-10100's four cores, and while this processor technically isn't unlocked for overclocking, you can get a little extra juice by manually raising the BLCK frequency. Manual memory overclocking isn't necessary here, though, as you can improve memory performance by activating the XMP mode in the BIOS, which should boost the operating frequency beyond the 2,666MHz default.

Is 500GB enough storage? Well, that depends. If you need a large amount of cheap, low-speed file storage, you can easily add a big HDD using the clip-in drive cages hidden under the PSU shroud. Otherwise, you might just want to spring for a 1TB SSD to replace the 860 Evo.

APC LABS BENCHMARKS

Indicates best result

	Cinebench R15 Multi	CrystalDisk QD32 Sequential	CrystalDisk QD32 Sequential	Rise of the Tomb Raider	Total War: Warhammer II	Tom Clancy's Ghost Recon: Wildlands	3DMark: Fire Strike
	Index	Read MB/s	Write MB/s	fps	fps	Avg fps	Index
Office hours	898	552	533	6	6	3	1,233
Zero-point	541	540	372	5	3	2	1,183

Our zero-point consists of an Intel Core i3-8100, 8GB of Team Vulcan DDR4 @ 2400, and a 120GB Kingston SSDNow UV400. All tests were performed at 1080p at the highest graphical profile.

QUICK TIPS

APC experts solve computing problems

The *APC* team tackle problems across the spectrum of devices and software. Learn a new trick or fix you can use.

CPU temperature fluctuation

I've been using Open Hardware Monitor to control my CPU fan. This was the only app I could find that controlled it. I have an Asus ROG Strix B450-F motherboard, AMD Ryzen 5 3600 overclocked to 4,150MHz, and the stock AMD CPU cooler. I tried to control the fan from the motherboard, but it didn't work. I also have two NVMe SSDs, two SATA SSDs, ODD, three 140mm case fans, and a 120mm case fan, all fans blowing inward, all housed in a Corsair 110R case.

My question is why does the temperature in the processor vary over a six-hour period when the voltage, fan speed, and room temp don't change? Do I need a better cooler? Check out the six-hour graph I have attached, and you'll see what I mean.
PAPA HOMEY

APC responds: Your CPU is never completely idle, so it's unsurprising that the temperature fluctuates as the CPU load changes – even if you've left it to its own devices. Background processes continue to run, while even light use of your PC to browse web pages or edit a text file will have some effect. All you need to do is open Task Manager to the "Processes" tab, then click on the "CPU" tab to see the constant ebb and flow in CPU usage, which will correlate to temperature changes.

Looking closely at your graph suggests that everything appears normal – your CPU temperature tends to fluctuate between 55-70C, which is well below the "safe" figure of 80C. Improving your cooling would help reduce this figure further, and *APC* is intrigued as to why all your case fans are drawing air into the case – you should ideally have the fans at the rear drawing colder air in, while fans at the front blow the hot air out. So, if you're not currently doing this, a simple rearrangement of your current setup should help drive those CPU temperatures down further – even when overclocked, your CPU should be around 40C while idling.

Is free software safe?

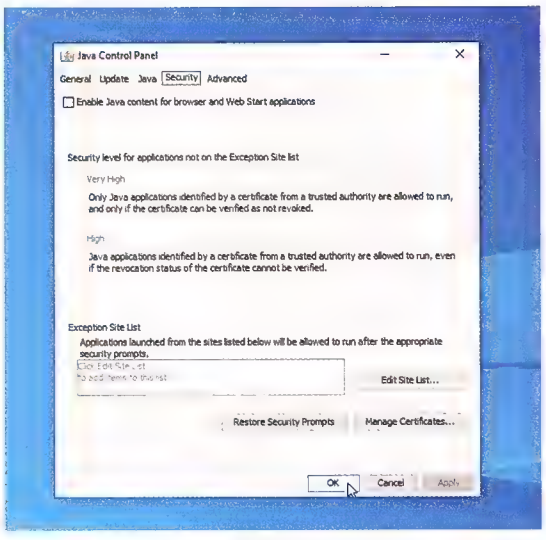
Two questions if I may: First, I keep getting these notices that Java needs to be updated. Is there a program out there that will list/show which programs I have on my computer that require/are using Java to run?

Second, APC usually recommends free software in some of its articles. Some of them look interesting, but I've always been concerned as to whether free software is safe to use. Do I have a reason to be concerned? Along those lines, I saw that you mentioned Malwarebytes. What is the difference between the free version and the version you purchase?
R.T.

APC responds: Sadly, there's no way to find out which applications require Java on your PC, short of generating a list of apps installed (use "Settings > Apps > Apps & Features") and then Googling each one to see whether Java is listed among its system requirements. Or you could simply remove all versions of Java from your PC using the Uninstall Java Versions tools (**www.java.com/en/download/uninstalltool.jsp**) and wait to see which programs complain when they can't find it (in which case, just download it again from **www.java.com**).

If the frequency of updates annoys you, type "configure java" into the Search box to open the Java Control Panel – use the "Update" tab to stop automatic updates or reduce the frequency of checks to monthly, but if you do so, we also recommend switching to the "Security" tab and unticking "Enable Java content for browser and Web Start applications" to close a potential security loophole.

Moving on to your second question, if the program gets a thumbs up from the mag, you can be sure we've investigated it thoroughly, scanned it with our own security software, and installed it on our computer. These days, there's usually a free program that offers most - if not all – the functionality of paid-for products. *APC* relies on lots of free apps on a day-to-day basis, whether it's Paint.NET for photo editing, Handbrake for video encoding, or Bitwarden for password management. We're particular fans of open-source programs, which make their code available for anyone to view, audit, or even fork off into a separate project. Such transparency makes them more trustworthy.


Java Control Panel
General
Update
Java
Security
Advanced
Enable Java content for browser and Web Start applications
Security level for applications not on the Exception Site list
Very High
Only Java applications identified by a certificate from a trusted authority are allowed to run, and only if the certificate can be verified as not revoked.
High
Java applications identified by a certificate from a trusted authority are allowed to run, even if the revocation status of the certificate cannot be verified.
Exception Site List
Applications launched from the sites listed below will be allowed to run after the appropriate security prompts.
Edit Site List...
Restore Security Prompts
Manage Certificates...
OK
Cancel
Apply

Disable web-based Java content.

That's not a universal guarantee, of course – there is plenty of dubious software out there, both free and paid-for, so the usual caveats apply. Start by reading up about an app that interests you – Google its name with keywords such as "review" and "malware" to gauge its reputation. If you decide to download it, make sure you do so from the author's website or a trusted mirror such as **MajorGeeks.com**. Also, be sure to scan the downloaded file for malware – your anti-malware software should do this automatically, but there's no harm in right-clicking it and choosing the "Scan" option to confirm.

Lastly, Malwarebytes Anti-

Malware is a great secondary layer of protection to run alongside your existing anti-malware program. The major difference between the free and paid-for versions is that the paid-for version offers four real-time protection components that cover malware, ransomware, exploits, and web (dodgy websites) – all without interfering with any existing anti-malware software. The free version will scan and remove malware threats, but you'll need to remember to run manual scans regularly.

USB Cable Replacement

Thank you for keeping up the magazine in these trying times. You guys are awesome! I had my joystick plugged into the USB 3.0 plug, in front of my machine. As I walked by, I bent and cracked the little plastic thing inside. So, I opened the case, removed the cable that plugs into the motherboard to find out that it split into two USB 3.0 connectors plugged into the front of my case. I called the manufacturer to find out they don't make them anymore, and they hung up on me. The cable is 40cm from tip to tip. Can you refer me to someone who makes them, as I'm having trouble locating one?
D DOMINGUEZ

APC responds: This question became a heck of a lot easier to answer because you've thoughtfully provided a series of photos of the defective part in question, which revealed the key connectors we needed to identify in order to source a generic replacement. At one end is a 20-pin female motherboard connector, while at the other are two female USB-A ports designed to slot into place in the case chassis. Sadly, you forgot to list the case make and model, which made things tricker.

The two female USB-A ports aren't molded in plastic, which narrows the available options down. In the end, we resorted to a Google Images search for "20-pin connector to USB port" to perform a visual inspection of potential matches. This led us to the closest match we could find, a 1.6-foot cable from Toptekits ($16.60, **www.amazon.com/dp/B010NBLRHK**). The biggest issue will be the Toptekits screw mount, which you may need to shave to fit your case.

If it's impossible to fit, you could try an alternative approach if you have a spare external 5.25-inch drive bay – fosa's 5.25-inch multifunction reader includes three USB 3.0 ports and one USB-C port for under $28 (**www.amazon.com/dp/B07CK17QSY/**), and connects to the same USB socket on your motherboard as the original cable.

Choosing Headphones

Dear APC, there are so many headphones! I'd like to purchase a sub-$300 pair of cans. It should have Bluetooth and ideally a wired 3.5mm jack, plus perhaps a removable or retractable microphone. Great sound goes without saying: I'm not a super-audiophile, but I would like a pair that will last me and be able to be used on both my PC to game with friends as well as to listen to some music in comfort.

There's so much choice, how do you begin to sort through them all? I'm starting from the beginning and am just so lost.
ARCHIMEDES INFERNO

APC responds: There's no substitute for piggybacking on other people's experiences – namely reviews – but while user reviews are important, you should always remember that many may be fake, although these tend to be easy to spot given they're so effusive with their praise. With that in mind, professional reviews from reputable magazines and websites like What Hi-Fi (**www.whathifi.com/products/headphones**) are crucial. These also help steer you away from one of the many dozens of cheap brands towards more established, reputable names.

Audio Technica is a well-regarded headphones manufacturer.

Beyond this, looking at your wish list, one crucial factor stands out: Longevity, which again highlights the importance of steering towards a well-known brand. This will push the price up but should still give you ample room within your $300 budget. The upside is that you'll gain access to a website with meaningful support, including forums where you can get a feel for a pair's reputation from other users – one thing to remember is that you'll find plenty of problems and complaints that may skew your feelings, but unless lots of people are reporting the same unresolvable problems, keep those gripes in perspective.

The other consideration you mention is comfort. Some people are fine with earbuds, whereas *APC* prefers larger cans that can physically block out the noise, while sitting comfortably over rather than inside the ears. That said, this type can grow uncomfortably hot with prolonged use, so consider how long you'd want to listen with them in a single sitting.

Finally, some other considerations: If you're opting for Bluetooth, choose Bluetooth 4.2 or later, and if audio quality is important, make sure it supports the higher-quality aptX (**www.aptx.com**) codec. Battery life isn't as important if you're mostly playing games, where you've got access to an easy charge, but you do want something that won't need constant recharging, so aim for 10 hours as a minimum.

Finally, if you're still struggling to start your search, visit a website like Static Ice (**www.staticice.com.au**) where you can input your budget to throw up a list of candidates. We stuck in your budget, and Static Ice suggested several models, including Audio Technica's ATH-SR5BT for $280. *APC*'s owned a pair of wired Audio Technica ATH-ES7 cans for nine years, so it's a brand we recommend. ■

WINDOWS

Take back Control Panel

Access hidden Windows features, with Mark Wyciślik-Wilson.

YOU'LL NEED THIS
Windows 10 Home/Pro
Any version will work

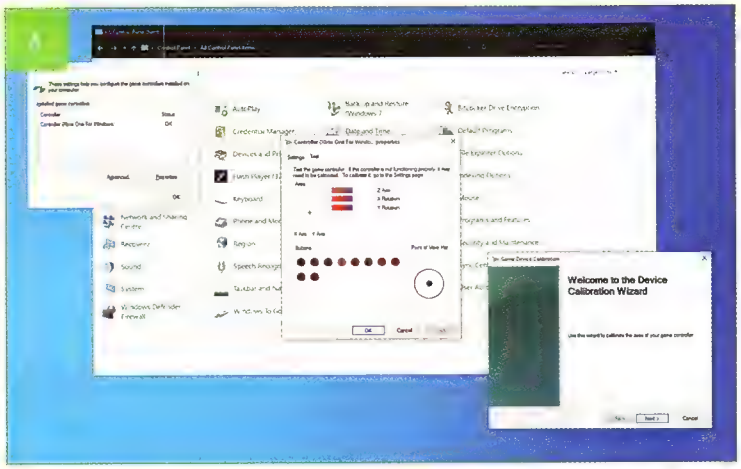
Ahhh that ancient and mystical Windows Control Panel, it's that one area that should've always remained sacrosanct to the Windows operating system. In fact it's been around in some form or another since 1985 and the launch of Windows 1.0.

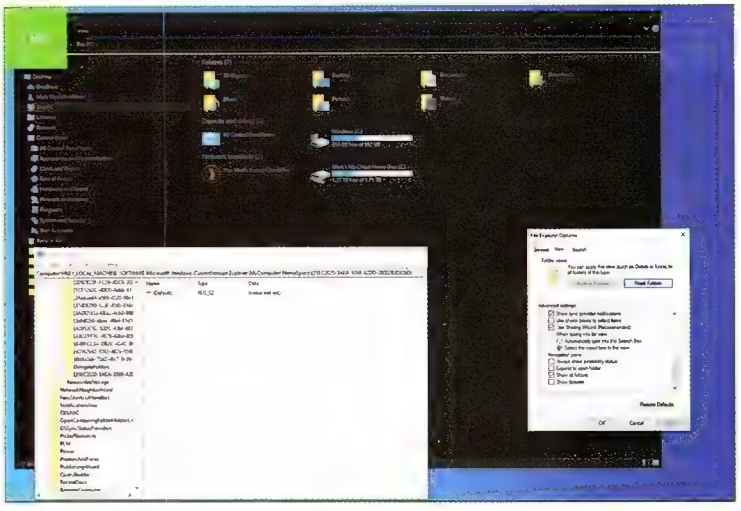
In those early editions of Windows, Control Panel was where you'd turn to if you wanted to change all manner of system-related settings. Whether that was hardware tinkering, trying to set up that pesky printer, or configuring a VPN to tunnel into your own home network when out and about, it's been an integral part of the Windows experience since its conception.

With Windows 10, however, Microsoft has attempted to largely replace the Control Panel for some unknown reason, with the far inferior Settings window. We say "largely" because although Settings enables you to access the vast majority of Windows' options, there are still some that are locked away in Control Panel. With this in mind, it is all the stranger that Microsoft continues to make it increasingly difficult to access this legendary area of Windows with each successive build. It feels as if, over time, Control Panel is slowly fading away into the background, but the truth is it is still there, and still immensely useful, and could well harbor some secrets that you might not even know about.

Finding Control Panel

Microsoft would prefer you to use Settings, so Control Panel is a little buried in the Start menu. You can find it by clicking "Start", and scrolling down to the "Windows System" folder. To save you from all of that scrolling, you can also just click the Start button and type "control panel" to perform a search for it – you just need to click the link that appears at the top of the list of results.





Search for settings

There are a huge number of options in Control Panel, and it can be difficult to remember where you should look for something – this is where the search function comes in. Control Panel functions much like a folder within Explorer, so you can search using the search box in the upper right-hand corner of the window, and easily hone in on something.

Secret search option

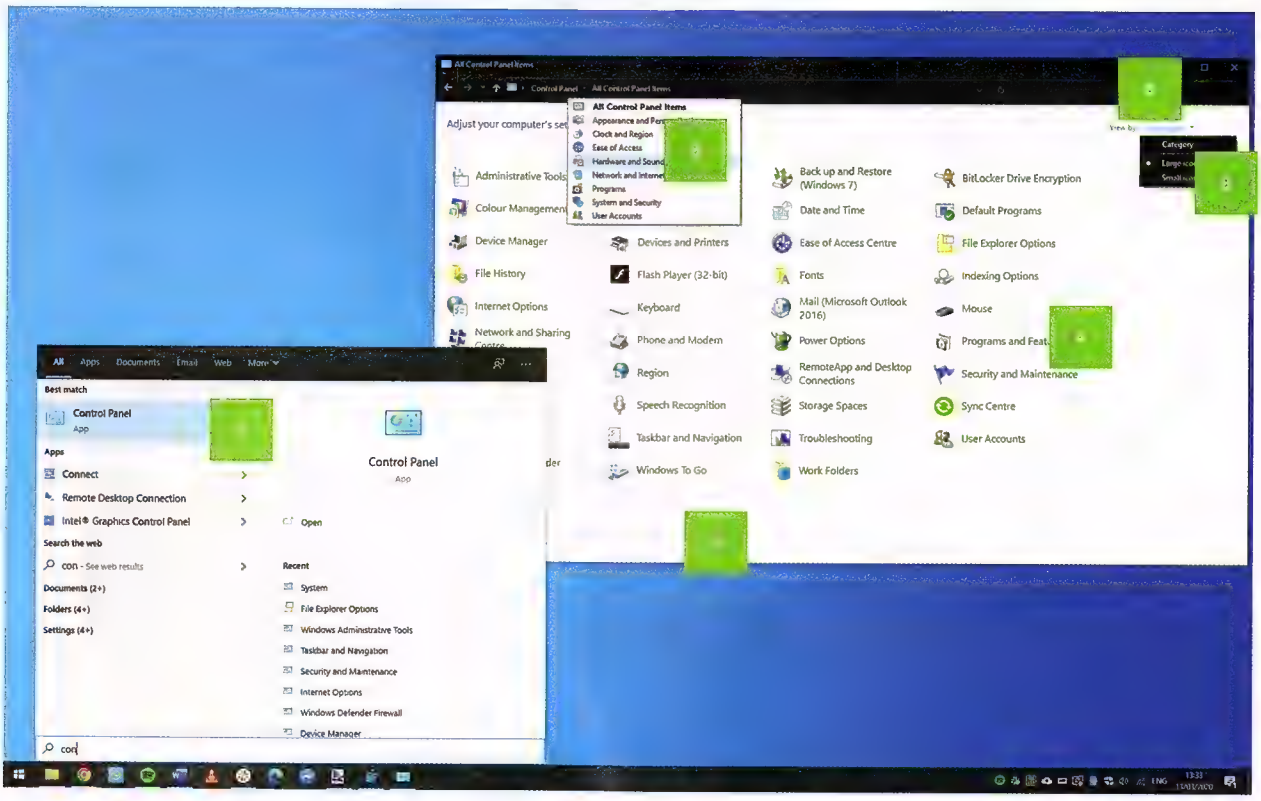
Searching can help you discover settings you've never heard of. Try typing "e" into the search box – because the vast majority, if not all, settings names include that letter – and press the Enter key. You'll be presented with a massive list of settings grouped together into categories. You just need to click one to jump straight to that Control Panel applet.

Secret game controller applet

If you're a gamer, you might be surprised to learn that there's a hidden "Game Controllers" applet. Press the Win and R keys to activate the Run dialog, type "joy.cpl", and press Enter. [Image A] Select your controller from the list, and click "Properties". On the "Test" tab you can check all of the buttons work, while on the "Settings" tab you can access the calibration wizard.

Access god mode

There is a hidden mode for Control Panel that has become known as "god mode". All it takes is the creation of a specially named folder. Right-click on the desktop, and select "New" then "Folder", before naming it "GodMode.{ED7BA470-8E54-465E-825C99712043E01C}" – you can replace "GodMode" with anything you like.



The Control Panel interface

1 START MENU
Searching the Start menu for Control Panel is perhaps the easiest way to find it to start with.

2 THE PANEL
Each icon in Control Panel represents an applet that can be used to change numerous system settings.

3 VIEW MENU
You can view Control Panel in different ways: all the applets at once, or grouping them by type of setting.

4 APPLETS
Some applets open within Control Panel itself, while others will open in separate dialog windows.

5 CATEGORIES
Whatever view you choose, you can browse Control Panel in Category mode by clicking the arrow in the address bar.

6 PANEL SEARCH
A quick and easy way to jump to a particular setting in Control Panel is to search for it using the search box.

Other hidden Control Panel shortcuts

Try creating these folders: "Application Connections. {241D7C96-F8BF-4F85-B01F-E2B043341A4B}"; "Default Programs. {17cd9488-1228-4b2f-88ce-4298e93e0966}"; "Firewall and Security {4026492F-2F69-46B8-B9BF-5654FC07E423}"; "Icons And Notifications.{05d7b0f4-2121-4eff-bf6b-ed3f69b894d9}"; "Programs and Features.{15eae92e-f17a-4431-9f28-805e482dafd4}".

Boost system performance

You can boost your computer's performance by disabling some animations and effects. Open "System" in Control Panel and click "Advanced system settings" to the left. On the "Advanced" tab, click the first "Settings" buttons under the "Performance" heading, then select the "Adjust for best performance" option – or manually specify what to disable.

Add Control Panel to File Explorer

You can add a Control Panel link to This PC via the Registry Editor. [Image B] Press the Win and R keys, type "regedit", press the Enter key, and navigate to "HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\MyComputer\ NameSpace". Create a new key called "{21EC2020-3AEA-1069- A2DD-08002B30309D}".

Customise desktop icons

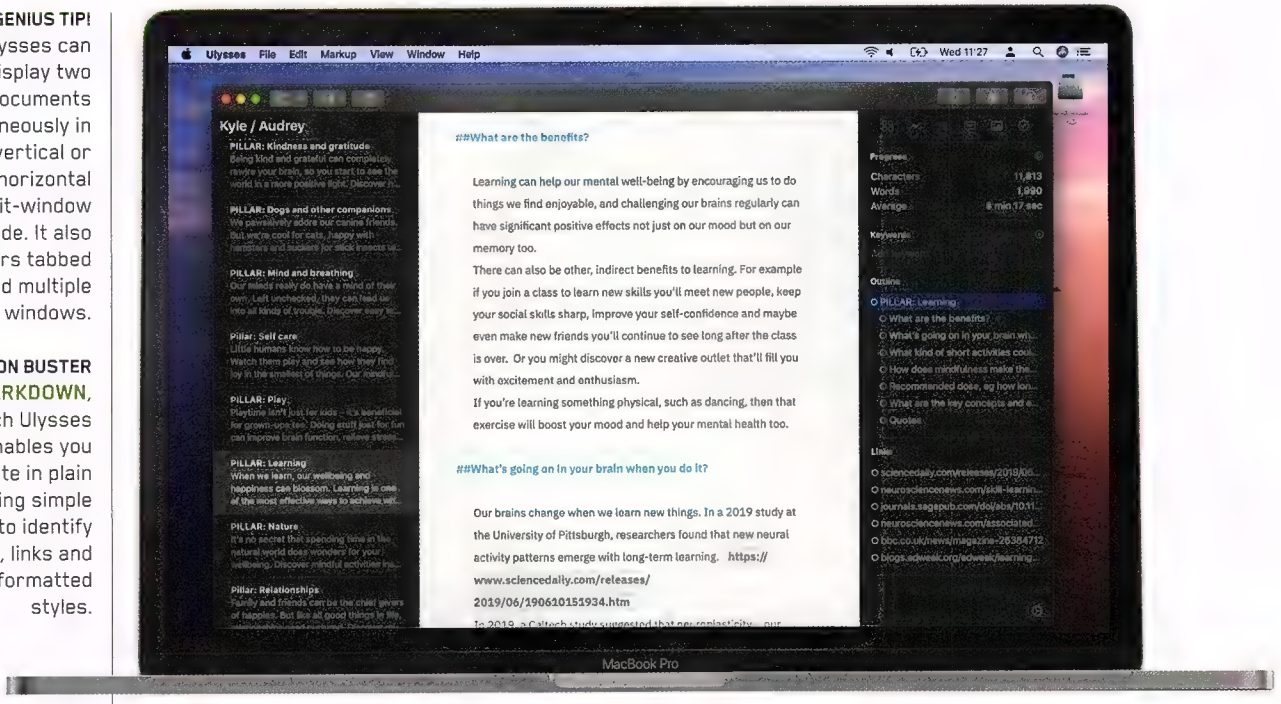
A slightly hidden Control Panel applet lets you choose which icons should appear on your desktop, including adding a Control Panel shortcut. Right-click on the desktop and select "Personalise", before moving to the "Themes" section. Click the "Desktop icon settings" link on the right, then use the tick boxes to choose which icons – This PC, Recycle Bin, etc. – should be displayed.

Helpful shortcuts (& screensavers!)

If you find that you use some Control Panel applets relatively frequently, you can create helpful shortcuts to jump straight to them from either the desktop or Start menu. Right-click on an applet, and select "Pin to Start" to add it to the Start menu, or "Create shortcut" to add it to the desktop instead. You can also access a hidden screensaver applet by creating a desktop shortcut that points to "rundll32.exe shell32.dll,Control_RunDLL desk.cpl,,1". ■

GENIUS TIP!
Ulysses can display two documents simultaneously in vertical or horizontal split-window mode. It also offers tabbed view and multiple windows.

JARGON BUSTER
MARKDOWN, which Ulysses uses, enables you to write in plain text using simple tags to identify headers, links and other formatted styles.


Ulysses File Edit Markup View Window Help
Wed 11:27
Kyle / Audrey
PILLAR: Kindness and gratitude
PILLAR: Dogs and other companions
PILLAR: Mind and breathing
Pillar: Self care
PILLAR: Play
PILLAR: Learning
PILLAR: Nature
Pillar: Relationships
##What are the benefits?
Learning can help our mental well-being by encouraging us to do things we find enjoyable, and challenging our brains regularly can have significant positive effects not just on our mood but on our memory too.
There can also be other, indirect benefits to learning. For example if you join a class to learn new skills you'll meet new people, keep your social skills sharp, improve your self-confidence and maybe even make new friends you'll continue to see long after the class is over. Or you might discover a new creative outlet that'll fill you with excitement and enthusiasm.
If you're learning something physical, such as dancing, then that exercise will boost your mood and help your mental health too.
##What's going on in your brain when you do it?
Our brains change when we learn new things. In a 2019 study at the University of Pittsburgh, researchers found that new neural activity patterns emerge with long-term learning. https://www.sciencedaily.com/releases/2019/06/190610151934.htm
Progress
Characters 11,813
Words 1,990
Average 6 min 17 sec
Keywords
Outline
PILLAR: Learning
What are the benefits?
What's going on in your brain wh...
What kind of short activities coul...
How does mindfulness make the...
Recommended dose, eg how lon...
What are the key concepts and e...
Quotes
Links
sciencedaily.com/releases/2019/06...
neurosciencenews.com/skill-learni...
journals.sagepub.com/doi/abs/10.11...
neurosciencenews.com/associated...
bbc.co.uk/news/magazine-26384712
blogs.adweek.org/adweek/learning...
MacBook Pro

MAC

What's new in Ulysses 20

One of our favourite writing apps is more useful than ever.

IT WILL TAKE
10 minutes
YOU WILL LEARN
About the new Dashboard in Ulysses 20
YOU'LL NEED
Ulysses, macOS 10.13 or later

We're huge fans of Ulysses, the do-everything writing app for macOS and iPadOS. No matter what we're writing – a document for review, blog post, magazine article, tutorial, book or song lyric or just a daily diary – we can write it in Ulysses and then share it in the appropriate format.

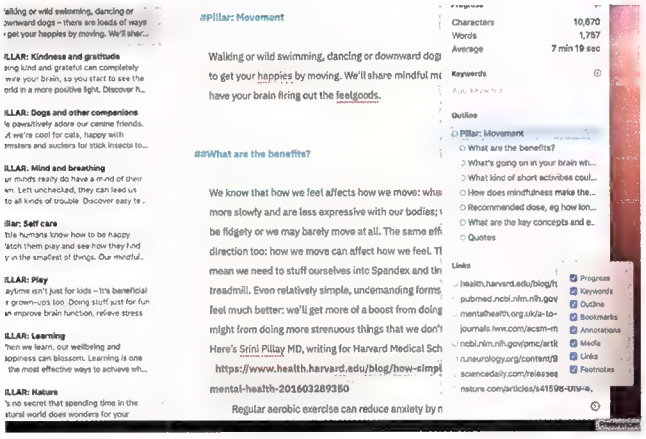
Because everything we do in Ulysses is stored in plain text there's no need to worry about using proprietary file formats; it also means Ulysses is blazingly fast. We can search our entire archive – many hundreds of thousands of words going back many years – and find what we want instantly.

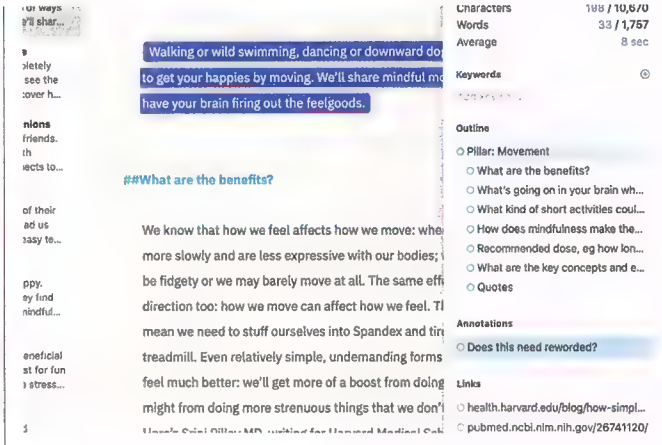
Version 20 is a big update to an already brilliant app. The biggest change is the new Dashboard, which is a sidebar at the right that is now packed with useful tools for navigation, annotation and reviewing.

As we'll discover, these tools don't just make navigating and organising your work easier, they can also help you improve your writing.

CARRIE MARSHALL

HOW TO Decode the Dashboard


#Pillar: Movement
Walking or wild swimming, dancing or downward dog
to get your happies by moving. We'll share mindful
have your brain firing out the feelgoods.
##What are the benefits?
We know that how we feel affects how we move: wha
more slowly and are less expressive with our bodies;
be fidgety or we may barely move at all. The same eff
direction too: how we move can affect how we feel. Th
mean we need to stuff ourselves into Spandex and tir
treadmill. Even relatively simple, undemanding forms
feel much better: we'll get more of a boost from doing
might from doing more strenuous things that we don't
Here's Srini Pillay MD, writing for Harvard Medical Sch
https://www.health.harvard.edu/blog/how-simpl
mental-health-201603289350
Regular aerobic exercise can reduce anxiety by
Characters 10,670
Words 1,757
Average 7 min 19 sec
Keywords
Outline
Pillar: Movement
What are the benefits?
What's going on in your brain wh...
What kind of short activities coul...
How does mindfulness make the...
Recommended dose, eg how lon...
What are the key concepts and e...
Quotes
Links
health.harvard.edu/blog/h
pubmed.ncbi.nlm.nih.gov
journals.lww.com/acsm-m
ncbi.nlm.nih.gov/pmc/artic
sciencedaily.com/releases
nature.com/articles/s41598-019-4...
Progress
Keywords
Outline
Bookmarks
Annotations
Media
Links
Footnotes


Walking or wild swimming, dancing or downward do
to get your happies by moving. We'll share mindful m
have your brain firing out the feelgoods.
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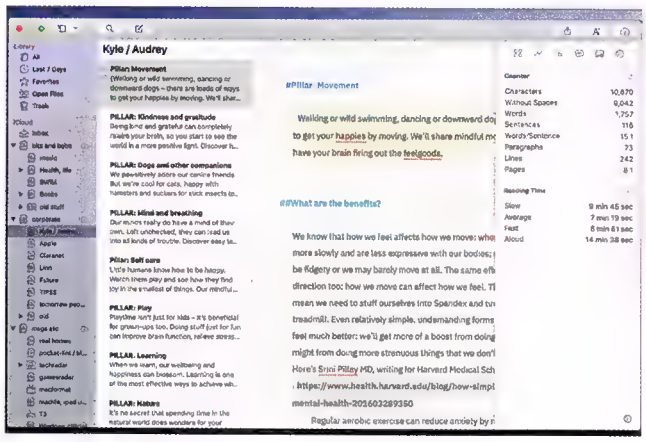
more slowly and are less expressive with our bodies;
be fidgety or we may barely move at all. The same effi
direction too: how we move can affect how we feel. Th
mean we need to stuff ourselves into Spandex and tir
treadmill. Even relatively simple, undemanding forms
feel much better: we'll get more of a boost from doing
might from doing more strenuous things that we don't
Characters 188 / 10,670
Words 33 / 1,757
Average 8 sec
Keywords
Outline
Pillar: Movement
What are the benefits?
What's going on in your brain wh...
What kind of short activities coul...
How does mindfulness make the...
Recommended dose, eg how lon...
What are the key concepts and e...
Quotes
Annotations
Does this need reworded?
Links
health.harvard.edu/blog/how-simpl...
pubmed.ncbi.nlm.nih.gov/26741120/

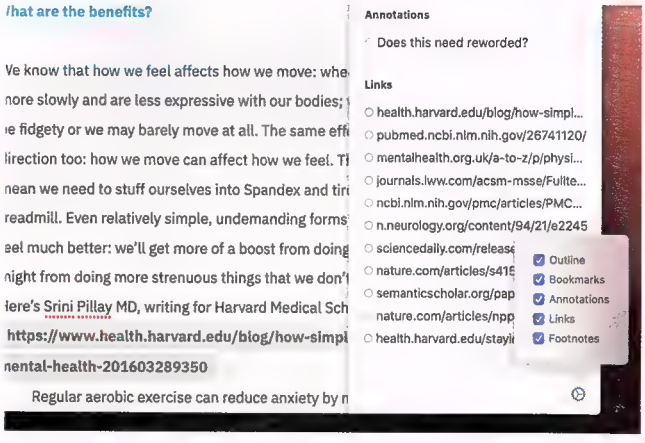
01 DISPLAY THE DASHBOARD
The Dashboard supersedes the attachments panel; for us it's gone from something we never use to a constant companion. To show or hide the Dashboard, click the icon at the top right of the window or tap option-4.

02 ADD AN ANNOTATION
You can use the Progress panel as a notepad: here we're adding an annotation to a block of text to remind us to revisit it. That annotation appears as a link in the Annotations section of the Progress panel.


Kyle / Audrey
#Pillar: Movement
Walking or wild swimming, dancing or downward dogs – there are loads of ways to get your happies by moving. We'll share mindful movement practices that will have your brain firing out the feelgoods.
##What are the benefits?
We know that how we feel affects how we move: when we're sad we often move more slowly and are less expressive with our bodies; when we're fidgety or we may barely move at all. The same effects happen in the opposite direction too: how we move can affect how we feel. That doesn't necessarily mean we need to stuff ourselves into Spandex and tire ourselves out on a treadmill. Even relatively simple, undemanding forms of movement can make us feel much better: we'll get more of a boost from doing more strenuous things that we don't might from doing.
Here's Srini Pillay MD, writing for Harvard Medical School: https://www.health.harvard.edu/blog/how-simple-mental-health-201603289350
Regular aerobic exercise can reduce anxiety by
Counter
Characters 10,670
Without Spaces 9,042
Words 1,757
Sentences 116
Words/Sentence 15.1
Paragraphs 73
Lines 242
Pages 8.1
Reading Time
Slow 9 min 45 sec
Average 7 min 19 sec
Fast 6 min 51 sec
Aloud 14 min 38 sec

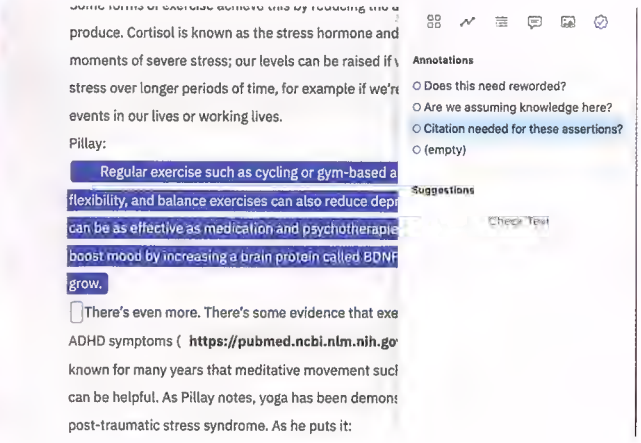
03 SEE YOUR STATS

If you're writing to any kind of numerical target, you'll love the Statistics panel. It displays word, character, paragraph, line and page counts. You can decide what to include or exclude here and specify your page sizes too.



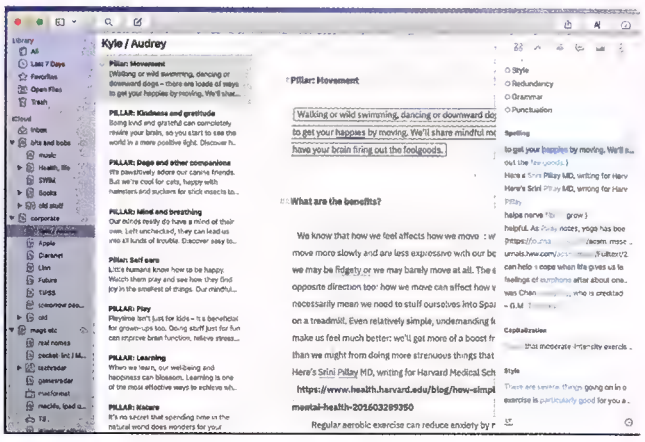
04 DRAG AND DROP

One of our favourite features is the ability to drag and drop text from another application or document and have Ulysses create a new Note. In this example, we're dragging a paragraph from Wikipedia we want to refer to.


produce. Cortisol is known as the stress hormone and
moments of severe stress; our levels can be raised if
stress over longer periods of time, for example if we're
events in our lives or working lives.
Pillay:
Regular exercise such as cycling or gym-based a
flexibility, and balance exercises can also reduce depr
can be as effective as medication and psychotherapie
boost mood by increasing a brain protein called BDNF
grow.
There's even more. There's some evidence that exe
ADHD symptoms (https://pubmed.ncbi.nlm.nih.go
known for many years that meditative movement such
can be helpful. As Pillay notes, yoga has been demons
post-traumatic stress syndrome. As he puts it:
Annotations
Does this need reworded?
Are we assuming knowledge here?
Citation needed for these assertions?
(empty)
Suggestions
Check Text

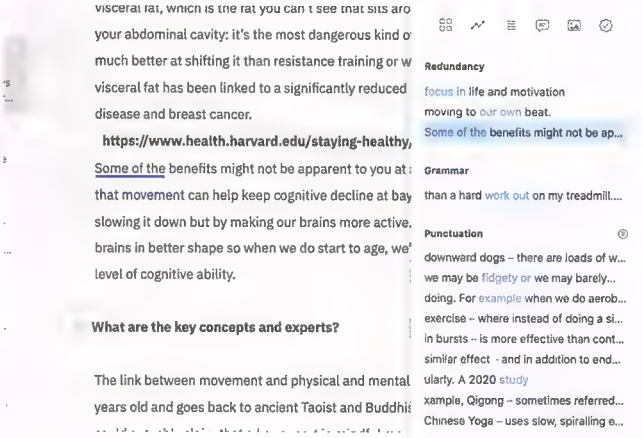
05 USE THE OUTLINE

If you use styles for headings and subheadings, Ulysses automatically turns them into navigation items in its Outline view. This panel is customisable and it can also include or exclude annotations, links and footnotes.



06 GET REVIEWING

The final part of the Dashboard is the Reviewing Mode, which enables you to see all annotations in the currently open document that you or a collaborator have made. It's like a simpler version of Word's Track Changes.


visceral fat, which is the fat you can't see that sits aro
your abdominal cavity: it's the most dangerous kind o
much better at shifting it than resistance training or w
visceral fat has been linked to a significantly reduced
disease and breast cancer.
https://www.health.harvard.edu/staying-healthy,
Some of the benefits might not be apparent to you at
that movement can help keep cognitive decline at bay
slowing it down but by making our brains more active,
brains in better shape so when we do start to age, we'
level of cognitive ability.
What are the key concepts and experts?
The link between movement and physical and mental
years old and goes back to ancient Taoist and Buddhi
Redundancy
focus in life and motivation
moving to our own beat.
Some of the benefits might not be ap...
Grammar
than a hard work out on my treadmill....
Punctuation
downward dogs – there are loads of w...
we may be fidgety or we may barely...
doing. For example when we do aerob...
exercise – where instead of doing a si...
in bursts – is more effective than cont...
similar effect - and in addition to end...
ularly. A 2020 study
xample, Qigong – sometimes referred...
Chinese Yoga – uses slow, spiralling e...

07 CHECK YOUR TEXT

Ulysses has partnered with LanguageTool, a third-party text checking service that works in 20 different languages. If you enable it, you can get the Reviewing Mode to quickly identify potential problems in your document.

08 ROOT OUT REDUNDANCY

The text check feature doesn't just run a spell checker. It can also identify dodgy punctuation, unnecessary capitalisation and overly flowery writing. Everything links directly to the appropriate bit of text.

iOS

iOS system maintenance

Use iMazing's tools to keep your iOS device spick and span.

Apple likes to keep your iOS device firmly locked down, and for the most part that is fine. Most of us are not interested in jailbreaking our devices and the risks that come with that, after all. But gaining more control does not have to entail risks – with iMazing 2, you can take a deep dive into your device and keep it well-maintained in a safe and easy way.

The various tools provided in iMazing allow you to do several useful things that Apple will not let you do, whether that is through Finder or in the Music, Podcasts, and TV apps. For instance, iMazing adds features like a profile manager and file system browser that are simply not available from Apple. These provide an extra level of functionality for managing and maintaining your device

Elsewhere, iMazing adds extra features to existing tools. While Finder will happily back up your iOS device, it does not give you many options. If you back up through iMazing, however, you can create an automatic backup schedule, choose where your backups are saved and whether they are archived, and more. It is an extra layer of control that, for whatever reason, Apple chose not to provide.

All these features make iMazing an excellent tool for keeping your device in tip-top shape. In this tutorial, we will guide you through how to maintain your iOS device the quick and easy way with this handy app.

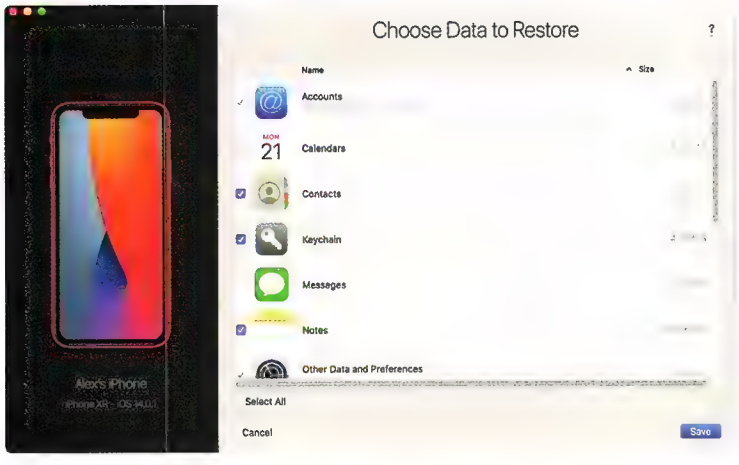
ALEX BLAKE

"iMazing adds features like a profile manager and file system browser that are simply not available from Apple. These provide an extra level of functionality for managing and maintaining your device."

IT WILL TAKE
20 minutes

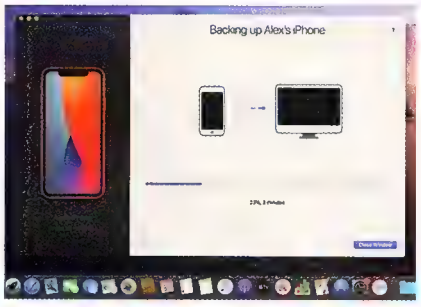
YOU WILL LEARN
How to take care of your iOS device using iMazing

YOU'LL NEED
iMazing 2 on your iOS device and your Mac, iOS 4 or later, OS X 10.9 or late



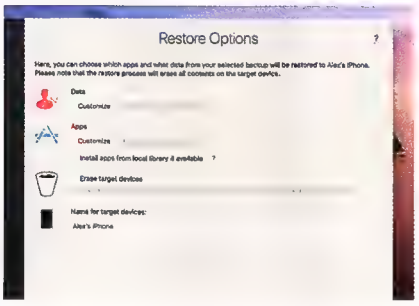
Restoring data from a saved backup is very straightforward in iMazing. You can choose to restore everything or only certain data.

HOW TO Take control of your iOS device



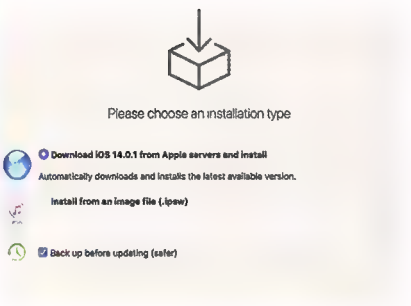
01 BACK UP YOUR DEVICE

Click Back Up in iMazing's right-hand menu to begin backing up right away. Alternatively, click the Options button in the same menu. Here you can choose a backup schedule and location, adjust archive settings, and more.



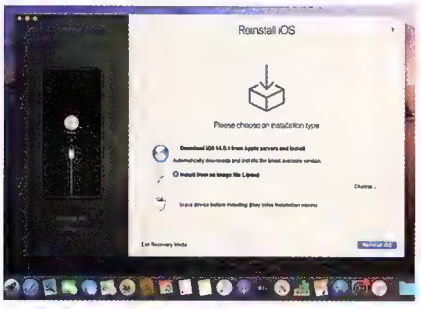
02 PREVIOUS BACKUP

To go back to an old backup, click Restore a Backup in the right-hand menu, select a file, then click Choose. Select what you want to restore from this backup and click Next, turn off Find My, then click Restore.


Please choose an installation type
Download iOS 14.0.1 from Apple servers and install
Automatically downloads and installs the latest available version.
Install from an image file (.ipsw)
Back up before updating (safer)

03 UPDATE YOUR IOS VERSION

Click Update iOS in the right-hand menu. If an update is available, iMazing will download it for you. Alternatively, if you have downloaded an update file (such as in the example here), select it in the Browse panel, then click Update.

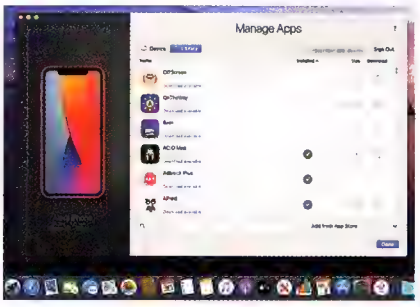


04 REINSTALL IOS

You can also reinstall iOS if you are having trouble with your device. Click Reinstall iOS, then click Reinstall and wait for the process to finish. This will erase everything on your device, so make sure you have backed up first.

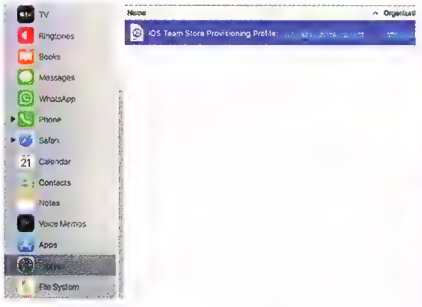
05 UPDATE OR UNINSTALL

There is no need to use the App Store to manage your apps. Instead, Click Manage Apps. From here you can update or uninstall any apps on your device. You can search for apps and see the version number for each.



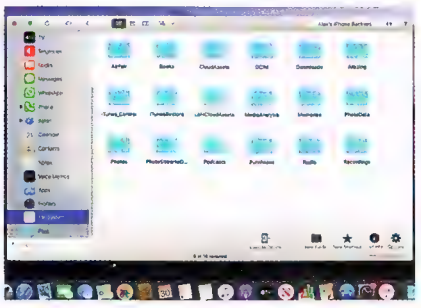
06 INSTALL APPS FROM ICLOUD

Alternatively, click the Library tab under Manage Apps. This will show every app associated with your Apple ID. You can choose apps that have been added to your iCloud account but are not on your device and install them here.



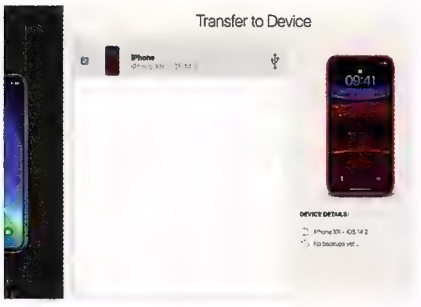
07 MANAGE IOS PROFILES

Certain apps or organisations may require a set of settings on their devices called profiles. To manage these, click Profiles. Here you can remove a profile or add a new one, or add one with iMazing's built-in profile editor.



08 EXPLORE THE FILE SYSTEM

If you are an advanced user, you may want to delve into your device's file system to export a certain document or media file. Click File System in the left-hand menu and browse to the file you want. Take care though!



09 TRANSFER FILES

iMazing can send your files from an old device to a new one. Click Transfer to another Device in the right-hand menu, choose the device, select what you want to transfer, and follow the on-screen instructions to complete the process.

More efficient disk space management

Like a spymaster in charge of countless subordinates, Shashank Sharma utilises a host of command-line utilities to keeps tabs on disk space.

Your Linux distribution is home to several nifty command-line utilities that can be used to report a variety of useful information. Everything from hard disk RPM, CPU temperature, network speed and more can be learnt with a single command. While we may well cover these utilities in future issues, our focus for now is on utilities that will reveal pertinent information about disk space.

If you've ever wanted to learn about the total disk space used and available on any given partition, the space used by different files and directories, and how you can free up space on your disk by identifying files which haven't been accessed in a long time, read on!.

We'll discuss several different commands in this tutorial. The `df` command is used to report the total space used and available for all different mounted file systems. The `du` command is similarly used to report the total space used by all the different files and directories. However, while this nifty tool informs you of the space used by the files, it doesn't help you decide whether you still need them. The `agedu` utility provides the same insight as `du` and also lets you know when each of the files were last accessed. You can then decide if you wish to back up, retain or delete older files, such as ones that haven't been accessed in, say, 12 months.

With the exception of `agedu` all the other utilities are already available in the default installation of most Linux distributions.

Using disk free

When you run the `df` command without any options, it will display the device name, total blocks, total disk space, disk space used, available disk space and the mount point on the screen.

If you've been using Linux for some time, then you'll already be familiar with its penchant for treating everything as a file. This explains the many virtual file systems, such as **/dev** being displayed along with actual mounted partitions.

```
Filesystem 1K-blocks Used
Available Use% Mounted on
udev 5971224 0 5971224 0%
/dev
tmpfs 1199880 3636 1196244
1%
/run
/dev/sda7 125465000
16717876 102330792 15% /
/dev/sda6 195312496
159229596 36082900 82% /
media/linuxlala/Stuffsies
```

The truncated output of the `df` command isn't immediately readable, as we're accustomed to seeing space referred to in sizes such as MB, GB and so on. You can use the `df -h` command to generate human readable output:

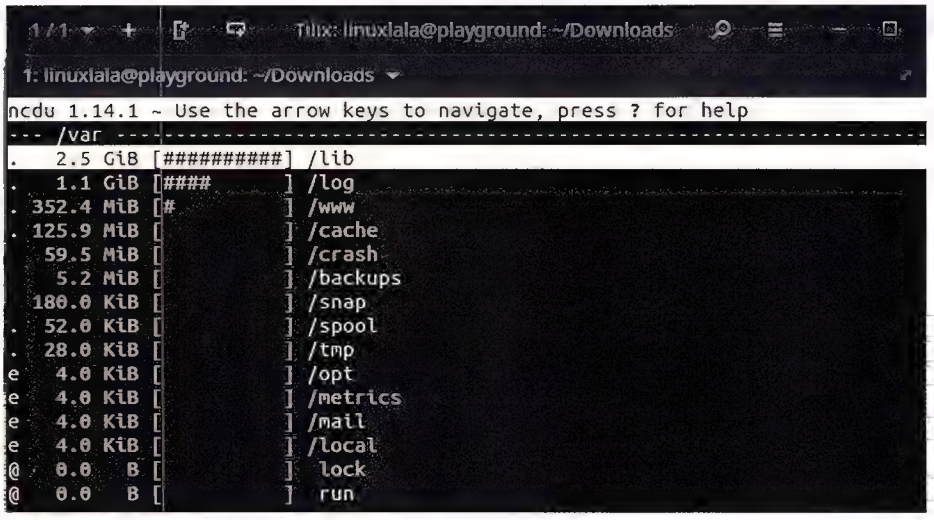
```
df -h
Filesystem Size Used Avail
Use% Mounted on
udev 5.7G 0 5.7G 0%
/dev
tmpfs 1.2G 3.6M 1.2G 1%
/run
/dev/sda7 120G 16G 98G 15%
/
tmpfs 5.8G 23M 5.7G 1%
/dev/shm
tmpfs 5.0M 4.0K 5.0M 1%
/run/lock
tmpfs 5.8G 0 5.8G 0%
/sys/fs/cgroup
/dev/sda6 187G 152G 35G 82%
/media/linuxlala/Stuffsies
```

The `df` command supports various other command options, which you can read about in the man page, or by running the `df -h` command.

The `df -h --total` command will add a line to the bottom of the output generated by `df` to show the total of all the different fields, as shown in this truncated output:

```
df -h
Filesystem Size Used Avail Use%
Mounted on
/dev/sda7 120G 16G 98G 15%
/
/dev/sda6 187G 152G 35G
82% /media/linuxlala/Stuffsies
total 366G 205G 154G 58% -
```

"If you've ever wanted to learn about the total disk space used and available on any given partition, the space used by different files and directories, and how you can free up space on your disk by identifying files which haven't been accessed in a long time, read on!"


1 / 1
Tilix: linuxlala@playground: ~/Downloads
1: linuxlala@playground: ~/Downloads
ncdu 1.14.1 ~ Use the arrow keys to navigate, press ? for help
--- /var ----------
2.5 GiB [##########] /lib
1.1 GiB [####   ] /log
352.4 MiB [#   ] /www
125.9 MiB [   ] /cache
59.5 MiB [   ] /crash
5.2 MiB [   ] /backups
180.0 KiB [   ] /snap
52.0 KiB [   ] /spool
28.0 KiB [   ] /tmp
4.0 KiB [   ] /opt
4.0 KiB [   ] /metrics
4.0 KiB [   ] /mail
4.0 KiB [   ] /local
0.0 B [   ] lock
0.0 B [   ] run

Ncdu provides the same functionality as du, but features a text-based interface. You'll find it in the software repositories of most distros.

Don't fret at the depicted total not matching with the listed entries. This is because we've had to truncate the output generated by the command for space constraints. In addition to mounted partitions and other identified filesystems, the `df` command will also mention all installed Snap packages.

If you're only interested in a single entry, such as the NTFS mounted partition, you can restrict the output of the `df -t [fileystem]` command to only that with the following command. For instance, the `df -t ext4` command will restrict the output to only ext4 filesystem, if any. You can similarly direct `df` to display details about the NTFS partition in human readable format by combing the `-t` and `-h` command options:

```
df -ht fuseblk
Filesystem  Size  Used Avail
Use% Mounted on
/dev/sda6  187G  152G   35G
82% /media/linuxlala/Stuffsies
```

When combing command options, like we have done in this example, the order is quite important. The `df -th` command fails, for instance.

QUICK TIP
Both df and du have inspired many clones over the years. You'll find various Python and Rust variant among others. A quick Google search will reveal all.

The first, second and third rule of disk space is that you'll run out of it. Happens to everyone. No exception. So it helps to keep tab on things.

Who you calling bulky?

Just as the `df` command reports the stats for mounted filesystems, the `du` command can be used to determine file space usage.

When invoked without any options, the `du` command display the size of all individual files and directories in the current working directory. While the utility supports a variety of command options, only some are of practical use:

OPTION	PURPOSE
-H	PRINTS HUMAN-READABLE OUTPUT INSTEAD OF BLOCK SIZES
-S	PRINT SIZE OF DIRECTORIES WITHOUT INCLUDING SIZE OF SUB-DIRECTORIES
--TIME	SHOW TIME OF LAST MODIFICATION OF FILE/DIRECTORY
-D [N]	SHOW ONLY DIRECTORIES THAT ARE N OR FEWER LEVELS BELOW.
--EXCLUDE PATTERN	EXCLUDE FILES/DIRECTORIES THAT MATCH PATTERN

The `-d` command option expects a numerical argument, where 0 implies current directory. So, if you run the command `du -h -d 1` , the output will be one level deep:

```
~/Downloads$ du -h -d 1
819M ./Telegram Desktop
16M ./TastyStatic
442M ./projects
1.3G .
```

As you can see here, even though all the directories have levels of sub-directories, the `du` command doesn't report recursively because of the use of the `-d` command option. This means that if you want to investigate two directories deep you'll have to run the `du -d 2 -h` command.

The size of each file is printed on a new line by the `du` command. When used without the `-d` command option, the output can be quite lengthy, depending on the contents of the directory. There may come a time when you might want to exclude certain files when using `du` . This is where the `--exclude` command options comes into play. It expects a PATTERN as argument, and all files/directories matching the PATTERN are ignored by `du` .

Depending on your use case, you may also wish to combine different command options such as `-d` with `--exclude` to narrow down the information reported by the `du` command.

Nifty utilities such as the ones discussed in this month's tutorial can help you gauge how your hard disk is coming along. When used correctly, a single command can reveal which directories can be pruned to save space. ■

Identify forgotten files

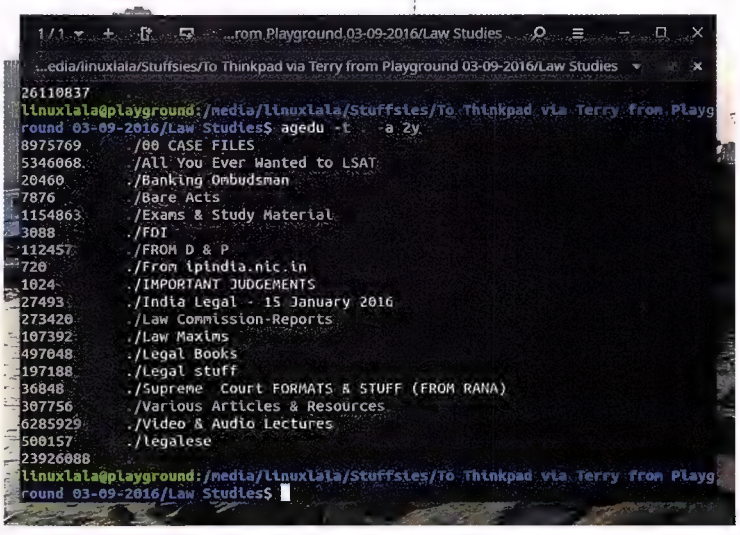
On a long-enough timeline, everyone runs out of disk space. This is the law. While you can't outrun this outcome, you can fend it off by being on the lookout for unnecessary files. For this tutorial, and because that's the purpose `agedu` serves, we define files that haven't been accessed in quite a while as unnecessary.

The utility is offered in the default installation by most desktop distributions. You can, however, install it using the software repositories. If you're running Debian/Ubuntu or a derivative distro, run the `sudo apt install agedu` command to install it. Users on rpm-based distros can similarly run the `dnf install agedu` command.

Before you start looking up files that haven't been accessed in a long while, you have to let `agedu` build an index of the directory you're interested in investigating. The `agedu -s ~/Downloads` command builds an index of the specified directory, in this case `~/Downloads`.

To view all files you haven't accessed in over two years, run `agedu -t <dir path> -a 2y` . The `-a` option expects a numerical value, as well as characters d, w, or y for days, weeks, or years, respectively.

In addition to generating text reports with the `-t` command option, you can also use the `-w` command option with `agedu` to generate a browser-accessible graphical report, which uses different colours to identify access times for the different files.


1 / 1
...rom Playground 03-09-2016/Law Studies
...edia/linuxlala/Stuffsies/To Thinkpad via Terry from Playground 03-09-2016/Law Studies
26110837
linuxlala@playground:/media/linuxlala/Stuffsies/To Thinkpad via Terry from Playground 03-09-2016/Law Studies$ agedu -t -a 2y
8975769 ./00 CASE FILES
5346068 ./All You Ever Wanted to LSAT
20460 ./Banking Ombudsman
7876 ./Bare Acts
1154863 ./Exams & Study Material
3088 ./FDI
112457 ./FROM D & P
720 ./From iptindia.nic.in
1024 ./IMPORTANT JUDGEMENTS
27493 ./India Legal - 15 January 2016
273420 ./Law Commission-Reports
107392 ./Law Maxims
497048 ./Legal Books
197188 ./Legal stuff
36848 ./Supreme Court FORMATS & STUFF (FROM RANA)
307756 ./Various Articles & Resources
6285929 ./Video & Audio Lectures
500157 ./legalese
23926088
linuxlala@playground:/media/linuxlala/Stuffsies/To Thinkpad via Terry from Playground 03-09-2016/Law Studies$

OPEN SOURCE MASTERCLASS

Build a meme generator with Python

Les Pounder shows us how to generate our own memes and filters using Python and standard open source tools.

The other day, while watching the episode of *Star Trek: The Next Generation* where Captain Picard was trapped on a planet with an alien who only spoke in metaphors made us think: "Hey we do that now with memes!" Memes are all over the internet and they're great fun to drop into a tweet. With this project we can make our own meme images using Python and a module named PIL (Python Imaging Library). To make it all a little easier for users we shall also make a simple GUI.

Software setup

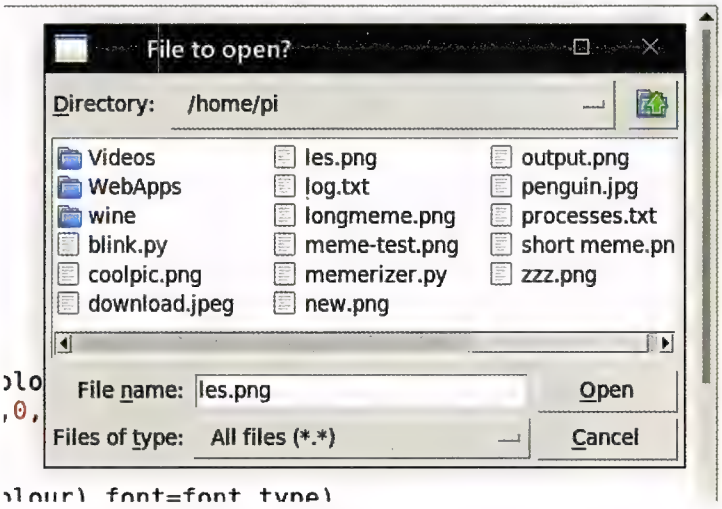
PIL comes pre-installed with Raspberry Pi OS, but we do need to install two extra packages. The first is imagemagick, used by PIL to work with images. In a terminal type the following to install it:

```
$ sudo apt update
$ sudo apt install imagemagick
```

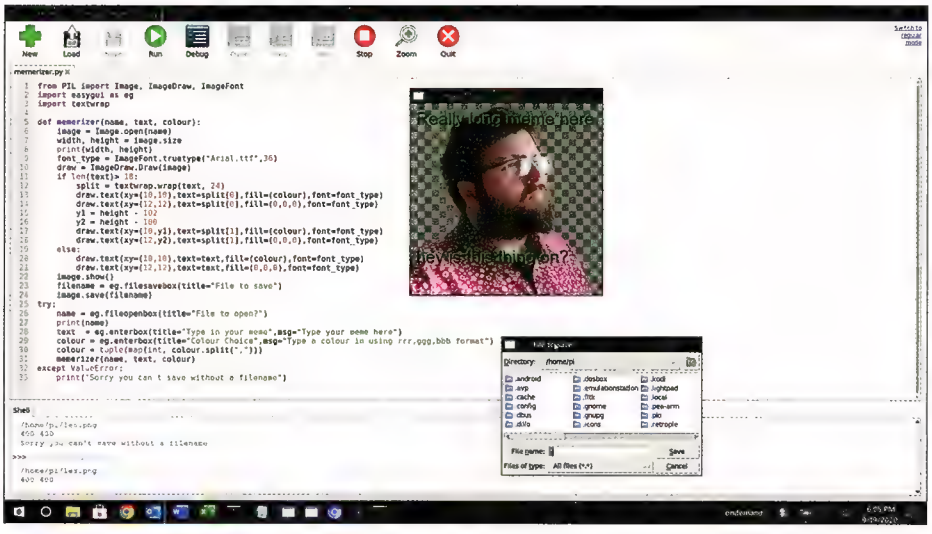
The next install is EasyGUI, which as the name suggests is an easy way to create GUI dialogs or menus in Python. Installation is via pip in the terminal:

```
$ sudo pip3 install easygui
```

With the installation complete, we can now move on to writing the code. Open your favourite Python editor – we chose Thonny, but IDLE, Geany or Mu will do the job. Create a new file and immediately save it as **memerizer.py**. Remember to save often.



EasyGUI is a handy, easy-to-use module that creates GUI elements such as dialogs, menus and more from simple code.



Create your own memes using Python and the PIL module. Add filters, rotate images and remix to find the ultimate expression of your mood.

We start the Python code by importing the PIL module, specifically three classes from the module. These are Image, enabling us to work with images, ImageDraw used to draw on images and ImageFont that provides the means to use text with images.

```
from PIL import Image, ImageDraw, ImageFont
```

The next two imports are the EasyGUI module, renamed to eg for ease of use and textwrap which will be used to trim long memes.

```
import easygui as eg
import textwrap
```

Generating the meme

Moving on and we next create a function – a sequence of code that runs when called. This function will handle all of the meme generation. Functions are defined and in this case our function is called `memerizer` and it takes three arguments (extra options) that are the name of the image file, the text for the meme and finally the colour of the text:

```
def memerizer(name, text, colour):
```

The next lines of code are inside the function and will only run when the function is used. All of this code is indented to show that it's part of the function. The first three lines will open the image using PIL and then store the width and height of the image into two variables, which are then printed to the Python shell for debugging:

```
    image = Image.open(name)
    width, height = image.size
    print(width, height)
```

We next create two objects. The first is used to specify the

font and its size and the second enables our code to create the text on the image:

```
    font_type = ImageFont.
truetype("Arial.ttf",36)
    draw = ImageDraw.
Draw(image)
```

An `if` statement is used to check the length of the meme entered by the user. If there are more than 24 characters, it will generate a new line: one line at the top and another at the bottom of the image. To do this it splits the sentence as near to 24 characters as it can. Then it writes the first line twice: once in the chosen colour, and another time in black and slightly offset:

```
if len(text)→ 24:
split = textwrap.wrap(text,
24)
draw.text(xy=(10,10),text=spli
t[0],fill=(colour),font=font_type)
draw.text(xy=(12,12),text=spli
t[0],fill=(0,0,0),font=font_type)
```

Positioning the text

Next we create two variables, `y1` and `y2` that are used to set the position of the second line of the meme. These two variables use the height of the image, minus 100 and 102 pixels to create the same offset drop shadow effect. We then repeat the same `draw.text` lines to create the text in the colour of our choosing.

```
y1 = height - 102
y2 = height - 100
draw.text(xy=(10,y1),text=spli
t[1],fill=(colour),font=font_type)
    draw.text(xy=(12,y2),text
=split[1],fill=(0,0,0),font=fo
nt_type)
```

But what if the meme text is short? Then the `else` condition is activated and just a single line of text is written to the top left of the image.

```
else:
draw.text(xy=(10,10),text=tex
t,fill=(colour),font=font_type)
draw.text(xy=(12,12),text=tex
t,fill=(0,0,0),font=font_type)
```

Out of the conditional test the code will show the meme image on the screen, before asking the user to save the image using EasyGUI's save dialog. This then sets the file name and location for PIL to save the image. This ends the function code.

```
image.show()
filename = eg.
filesavebox(title="File to save")
image.save(filename)
```

Starting a new section of code, we use a try, exception handler. The first few lines of this section will try to run the code that will first use EasyGUI's file open dialog to get the image file that we wish to use in the meme. Then the code will ask for the meme text:

```
try:
    name = eg.
fileopenbox(title="File to open?")
    text  = eg.
enterbox(title="Type in your
meme",msg="Type your meme
here")
```

The next two lines will ask the user to supply the text colour as an RGB value. For example, red is 255,0,0. A value of 255 means we have the maximum amount of that colour. Learn more about this at **www.rapidtables.com/web/color/RGB_Color.html**. The text provided by the user is stored as a string, but we need to convert this to a tuple, so we map the integers in the string and update the "colour" object to become a tuple.

```
    colour = eg.
enterbox(title="Colour
Choice",msg="Type a colour in
using rrr,ggg,bbb format")
    colour = tuple(map(int, colour.
split(",")))
```

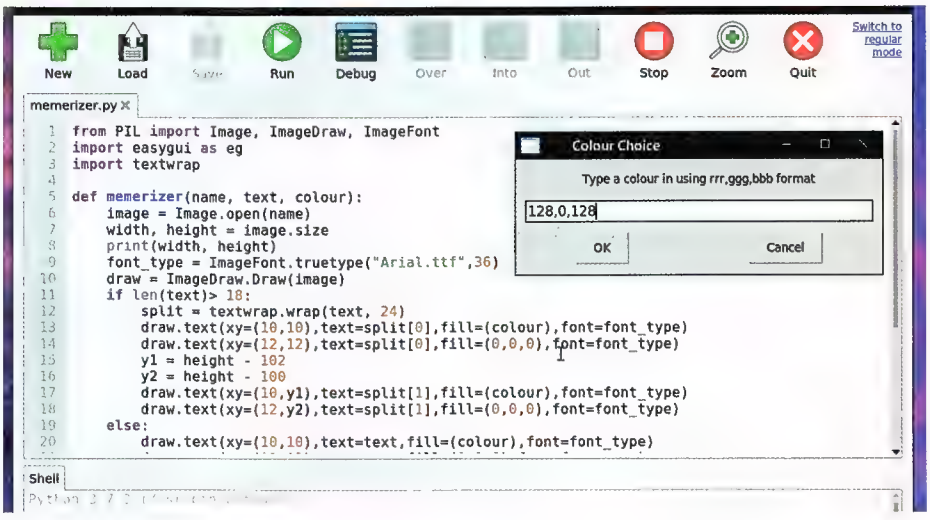
Next we call the `memerizer` function and provide the three arguments that it requires to generate our meme.

```
    memerizer(name, text,
colour)
```

The final two lines of code are the exception handler, used when a Value Error is encountered. This will print a friendly message to the Python shell.

```
except ValueError:
    print("Sorry you can't save
without a filename")
```

Save the code and click on Run to generate your own memes using Python!



Text colour is controlled using RGB values. These use numbers between 0 and 255 for each colour, mixing to make new colours.

YOU'LL NEED
•Code: **tinyurl.com/APC490CODE**

QUICK TIP
PIL has great documentation to help you learn more at **https://pil.readthedocs.io/en/latest**. There's also a fork of PIL, called pillow which is even easier to use. More details can be found at **https://pillow.readthedocs.io/en/stable/**

PIL - The Python Imaging Library

As used in this tutorial, PIL is a great tool to use with images in Python. It's simple enough to understand and results are easy to achieve. Let's take filters for example. Filters can change aspects of an image and you will have used them with apps on your smartphone. PIL can use filters to blue, sharpen, smooth, emboss and enhance the edges of images.

To use a filter we need to import the ImageFilter class from PIL and then pass it the filename of the image that we want to use.

```
from PIL import Image, ImageFilter
image = Image.open("image filename here")
```

Then we apply a filter in this case we blur the image. Then we show the image.

```
im1 = im.filter(ImageFilter.BLUR)
im1.show()
```

The filtered image can now be saved to a new file.

```
im1.save("PATH TO SAVE THE FILE")
```

Images can also be rotated, resized and manipulated all using code. Here we rotate the previously used image 45 degrees anti clockwise.

```
im1.rotate(45).show()
```

This will rotate and show the image on the screen.

BUDGET PC UPGRADES MASTERCLASS

Recycle, repair, restore, reuse

Don't consign your old PC to the scrapheap. Whether it's busted, battered, broken or just plain bad, Darren Yates looks at what you can do with your old computer systems.

There's nothing wrong with 'shiny and new', but there's a lot to be said for learning to recycle your old tech, knowing how to repair what you can, having those restoration projects and re-using the tech you've got in new applications. The skills you learn can stay with you for a lifetime.

Recycle

These days, there's no excuse for tech disappearing into landfill. Even if you no longer have use for it, there are many ways to responsibly off-load your old kit. For starters, try turning it into some cold, hard cash via Ebay, Gumtree or your local Facebook community swap-sell page. The trick is knowing the prices for brand-new systems and pricing yours accordingly. PCs are a lot like new cars – they lose value as you're walking out of the door, but the big mistake is sellers thinking their kit is worth more than it is.

If you're not comfortable with selling, contact your local council about e-waste disposal. Many councils operate a free e-waste pick-up service for residents, as well as quarterly or half-yearly drop-off days.

However, seeing tech being used is ideal, so if you no longer have use for it, there's likely someone who does. If you're thinking of heading off and dumping your old tech at your local charity, just stop right there. Most charities are not set up to handle PC donations, so at the very least you must ask them first, but otherwise, look for organisations specialising in this area. Googling 'PC donate' is a good start.

Nevertheless, whatever you do, delete all personal data from your device before you hand it over. Wipe the drive and reinstall the OS if you can.

Repair

These days, 'repair' seems an ugly word, but it's gold. A couple of years ago, my Canon HF10 video camera copped some coal dust while I was videoing a steam train. Bits of coal got into the lens mechanism, blocking up the worm gear so that the auto-lens cover wouldn't close. Rather than toss the camera or find a repairer, I bought the service manual online, a jeweller's screwdriver set and carefully dismantled the camera myself, taking phone pics along the way to document how all the different parts were installed. After finding the offending bits of coal, I cleaned the worm gear, gave it a thin coat of light machine oil, put it back together and it still works today. I'd never attempted this before but in the end, I spent $30 and a few hours but gained a wealth of knowledge, confidence and satisfaction.

The PSU is just one component you can replace in good desktop PCs.

Repairing a PC might seem completely different, but not as much as you might think. You might be thinking what's in a PC that you can repair? Even being able to narrow down faults to a particular component is an important repair step, so that if you need to, you buy a replacement part to get the PC back up and running. It doesn't have to mean attacking your motherboard with a welding torch (hint: don't).

If you can build a PC by now, you should learn how to troubleshoot and fix one and like most things, the best way of learning is by doing. Case in point, I'm still running an Intel Core i5-2300 'Sandy Bridge' PC from 2012. The motherboard received its last BIOS update in 2014 and continues to get flogged on a daily basis. It's had several drive upgrades, a PSU replaced and now runs 16GB of RAM, but it works. Some might think this false-economy, but I've learned far more from repairing PCs than I ever would buying them.

"If you're thinking of heading off and dumping your old tech at your local charity, just stop right there. Most charities are not set up to handle PC donations, so at the very least you must ask them first, but otherwise, look for organisations specialising in this area."

Original Commodore 64 computers are a popular restoration project.

Restore

During WWII, electrical engineer Tommy Flowers designed and built Colossus, the world's first all-electronic computer, to help

crack Hitler's secret codes. However, at the end of the war, all 12 computers and the designs were ordered destroyed by Winston Churchill. Still, the National Museum of Computing team at Bletchley Park gathered up details and eventually flicked the switch on a replica Colossus computer in 2008.

Restoring tech to its former glory today might seem counter-productive, particularly when we're always after 'faster', but having a restoration project on the go is always a good thing to have. The original Commodore 64 computer has become a popular restoration target. If nothing else, it gives you an understanding of where we've come from, technologically, and also helps in your troubleshooting and learning skills.

You must always respect electricity and take all necessary precautions but instead of having a pile of parts, why not restore your old PC back to its original glory?

Re-use

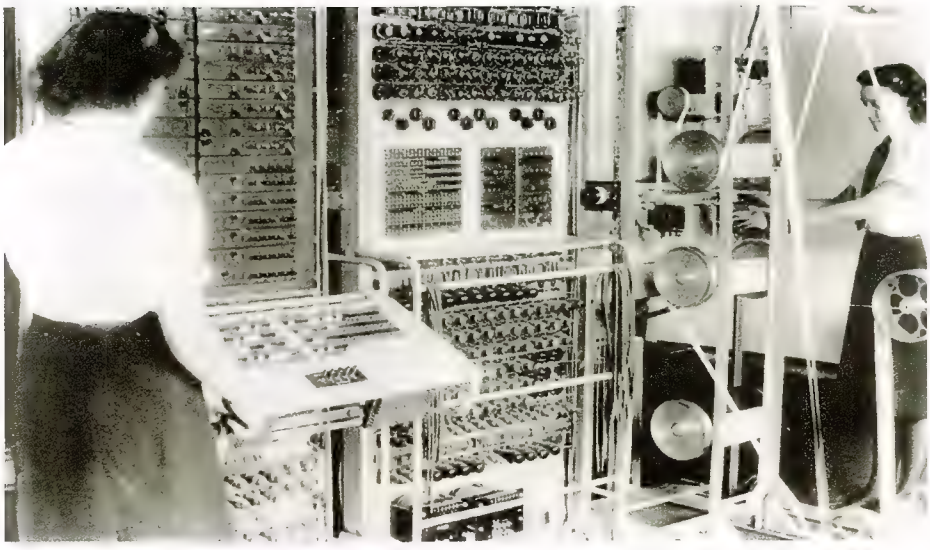
But after all this recycling, repairing and restoring, the fun bit is the re-use. We've looked previously at how to reuse your old PC, laptop, phone or tablet and for the PC specifically, one of the simplest ways may well be installing a new operating system.

Your old box may have had Windows XP or Windows 7, so while it may not be fast by today's standards, it'll likely still have sufficient horsepower to run a lean Linux distro.

There are plenty of Linux distros to choose from, starting from very lean, lightweight options such as Puppy Linux, through to Lubuntu (**http://lubuntu.me**) and Xubuntu (**http://xubuntu.org**) that offer a nice mix of lean features without the bloat, right through to full-kit Ubuntu and Debian with all the bells and whistles.

The benefit of a new OS is it can add new security capabilities the old OS may no longer support. Most lightweight Linux distros like Lubuntu will run happily on 2GB of RAM and 20GB of storage, so you don't need the latest kit to get them up and running.

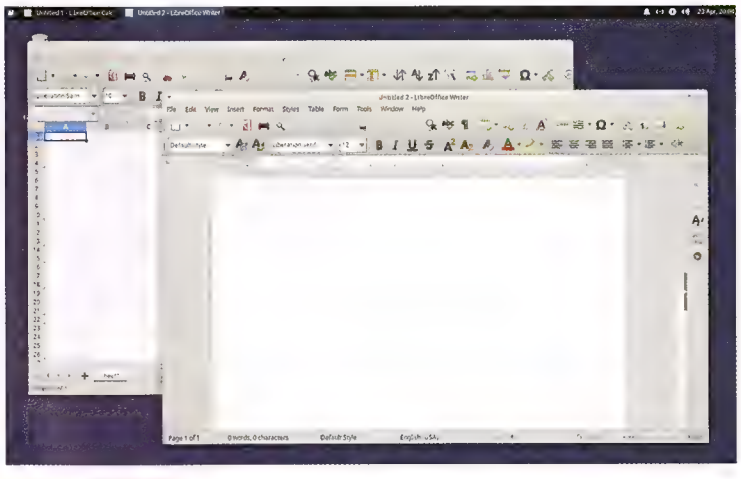
A new OS might also make it possible to upgrade the hard drive to an SSD. It's well known that Windows XP isn't ideal at SSD maintenance, so a modern OS may help here.



Colossus computers hacked Hitler's secret messages during WWII.

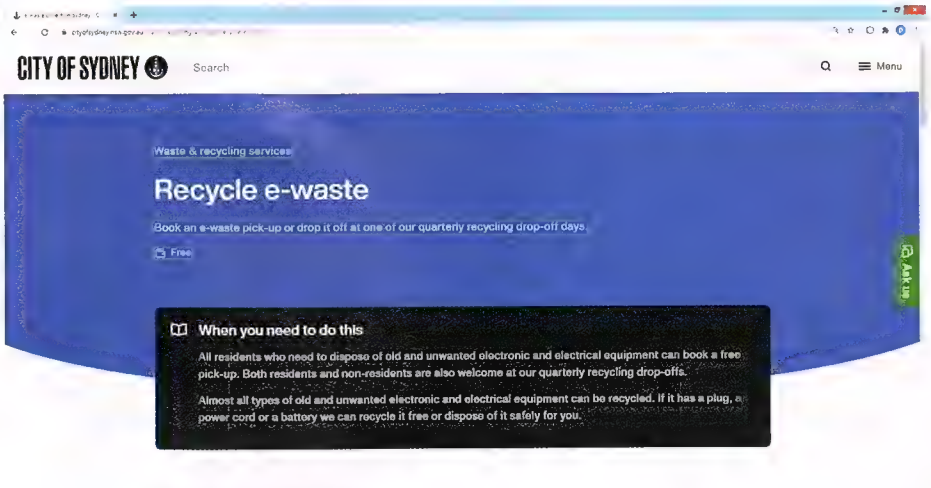
Be safe

Just to be clear, we're not talking about 'hardware hacking' here – making the hardware do something it wasn't meant for. As I mentioned before, you must respect 240VAC mains power and take all necessary precautions whether you're building a PC or repairing one. However, most PCs are tossed long before their actual use-by date, so learning to recycle, repair, restore and re-use your PC tech can end up saving you cash, even if it just delays the inevitable upgrade for a while longer.



Right: Xubuntu is my go-to OS for upgrading older PCs.

Below: Many councils now have a free e-waste pick-up service for residents.


CITY OF SYDNEY
Search
Menu
Waste & recycling services
Recycle e-waste
Book an e-waste pick-up or drop it off at one of our quarterly recycling drop-off days.
Free
When you need to do this
All residents who need to dispose of old and unwanted electronic and electrical equipment can book a free pick-up. Both residents and non-residents are also welcome at our quarterly recycling drop-offs.
Almost all types of old and unwanted electronic and electrical equipment can be recycled. If it has a plug, a power cord or a battery we can recycle it free or dispose of it safely for you.
What you need to do

MACHINE OF THE MONTH

Apple II

John Knight explores the brainchild of Apple's other Steve, the genius that is Steve Wozniak.

The Apple II (stylised as the Apple][) was one of the original mass-market home computers, but would become synonymous with colour computing, distinguishing itself from rivals made by Commodore and Tandy. Unhappy with the state of personal computing, Wozniak wanted to create something "small, reliable, convenient to use, and inexpensive." Following the stylistically crude but technologically promising Apple 1, Wozniak wanted to create a machine that was faster and more practical, with colour graphics.

While Steve Jobs concerned himself with selling the machine and making it pretty, Wozniak would create a piece of engineering beauty still admired today. Widely regarded as a primary influence on the IBM PC, the Apple II created the first real platform with long-term support for home consumers, with an emphasis on open architecture and expandability. With an astonishing production run stretching from the '70s to the '90s, the Apple II would be the machine to launch the company into the mainstream, and be its main source of income for over a decade.

Simple substance

Elegant simplicity is the central theme behind the Apple II and Wozniak's engineering methods: He had an obsession with using fewer components, stripping things back to their most elegant form, adding reliability and lowering prices. In multiple areas, Wozniak found clever workarounds that removed the need for extra RAM and chipsets used by the competition, while adding colour graphics.

Launching in June 1977, the Apple II was based around the trusty MOS 6502 CPU and shipped with 4KB of RAM, but wealthier owners could easily expand to 48KB in minutes. Initially the II used cassettes for storage, but it wasn't long before users demanded floppy support. Wozniak's resulting floppy drive is particularly famous among engineers, being stripped back and redesigned to the point where it cost a fraction of existing units.

If you're a die-hard PC fan who rages at the very mention of Apple, don't worry, it's OK to like the Apple II! Being primarily a creation of Steve Wozniak instead of Steve Jobs, the Apple II is a fundamentally different product to the Apple of today, following almost opposite ideals.

Based around open architecture, the Apple II is generally regarded as a primary influence on the IBM PC, and would even spawn numerous clones, such as the Franklin ACE 100 and VTech's Laser 128. Something to embarrass most PCs: The Apple came with eight expansion slots, and even had an easy-access lid.

SPECIFICATIONS **CPU:** MOS Technology 6502 @ 1.02 MHz **RAM:** 4KB up to 48KB **Launch price:** US$1,298 **Graphics:** 16 colours @ 40x48, 6 colours @ 280x192 **Sound:** CPU-driven 1-bit speaker **Storage:** 5.25-inch floppy, audio cassette, later hard disk upgrades **OS:** Integer BASIC/ Apple DOS **Released:** June 1977 **Production:** 1977-1993 **Worldwide sales:** N/A

The II also launched Apple's familiar rainbow-striped logo, highlighting the machine's colour graphics.

The beginnings of Apple's success

The Apple II found its foothold in the business world with the release of Software Arts' VisiCalc (1979), the first proper spreadsheet for home computers. Demand for the machine soon spread beyond American borders, forcing engineering modifications

for Europe and Japan (French software titles are particularly common). The Apple's colour graphics and simple operation also made it a hit among gamers – any classic eight-bit title is likely to have an Apple II port.

Despite Apple betting that the Apple II would only last a few years, strong sales continued for far longer than anticipated, backing up the company while products such as the Apple III and Lisa failed.

Re-focusing attention on the II, Apple used newer technology to update the line with models such as the hugely popular Apple IIe (1983), which slashed costs by stripping the number of components to less than a third, while adding RAM. Apple would shrink the II further with the IIc (c meaning "compact"), launching in 1984 and lasting until 1990.

The Apple II name would continue into the '90s with the IIGS line, but this was really a whole new computer, with a 16-bit CPU and full-colour desktop – something we'll save for a future issue. The Apple II finally earned its true retirement with the Platinum IIe, which was discontinued in November 1993, almost a year after the 16-bit IIGS.

It had sold over 5 million units (6 million including the IIGS) over three separate decades.

Emulating the apple ii

There are plenty of emulators available, including general-purpose and even browser-based options, but we prefer something bespoke. Our choice is AppleWin – it has the friendliest interface by far and excellent emulation. AppleWin is currently Windows only, but if you're a Linux user, AppleWin is GPL open source and runs excellently under Wine.

If you would prefer to use native Linux software, Apple II cores are easily available for general-purpose emulators like MAME and RetroPie. But for Apple II-specific emulation, we can also recommend The Octalyzer, microM8, and LinApple (though LinApple needs to be compiled from source). Our chief pick would be microM8, which has an interesting keyboard-driven interface: **https://paleotronic.com/software/microm8/**

Returning to AppleWin, the provided link takes you to a Github repository. Towards the bottom of the page is a link labeled "Download latest (stable) release." Grab this, and once downloaded, extract the zip file and open the new folder. AppleWin doesn't come with an installer, so you'll need to open the Applewin.exe executable manually – you might want to make a desktop shortcut.

Woz used clever engineering tricks to achieve colour, though it can have a strange washed-out look at times.

YOU'LL NEED APPLEWIN

We couldn't find any minimum requirements for AppleWin, but not much. Really not much. A solid version of Wine if you're using Linux. **https://github.com/AppleWin/AppleWin**

Usage

By default, AppleWin emulates the Enhanced Apple IIe, which had an auto-boot facility. That will make it very easy to get started. Just click the floppy drive icon labeled with a "1," choose the program you want to load into the virtual floppy drive, then click the coloured Apple icon to start/restart the machine.

If you have a program spread over multiple disks, you can use the second virtual floppy drive as well. The icon below enables you to switch the drive order, in case you need to do any mid-program disk swapping.

Once a program is launched, Alt-Enter will enable full-screen mode. Assuming you don't have a real joystick connected, AppleWin will emulate a joystick via the keyboard. By default this will use the number pad for movement, and the "Alt" button for fire, but this can be changed in AppleWin's configuration window.

To configure AppleWin, click the icon with the picture of a speaker and a joystick. Of primary interest in the "Configuration" tab are "Model" and "Video." "Model" will be set to Enhanced Apple IIe by default, but can be set to older models like the original Apple II, or a "Clone" machine. "Video" will be set to "Colour TV" by default, but if you've never seen Apple II colour graphics before, you may find it unattractive! Other options are available, such as a proper monitor, or monochrome.

In the "Input" tab, you can define your joystick inputs, including whether to enable a joystick or not, whether to use keyboard emulation with the number pad or cursor keys, with a mouse, or select an actual joystick. ■

Find software

If you're after trying out some free software then **https://archive.org** has plenty of programs for you to get stuck into and play with, including both games and work applications.

If you can't be bothered to install an emulator, Virtual Apple II runs in your browser and has a great collection of software for both the II and IIGS. It even has extra controls allowing you to switch between colour and black and green single-colour mode. The browser plugin only works under Windows and Mac, so definite points off there, but at least it provides disk images that an emulator can use: **http://virtualapple.org**

However, the most interesting resource is Call-A.P.P.L.E., which has been serving the Apple community since 1978. Here you can find everything from books and magazines to new games made by fans. There we found links to the work of Vince Weaver, who has been making blocky eight-bit reworks of *Myst* and *Another World* – a fabulous waste of time that gets our official thumbs up! **https://www.callapple.org/**

Assassin's Creed Valhalla quietly adds better PS5 haptic support in new update

The biggest change appears to be a new implementation of the adaptive triggers when you're wielding the bow: the right trigger now provides some resistance when Eivor pulls back an arrow, simulating the tension of the bowstring. Some players report more of the general rumbling haptic feedback when attacking with melee weapons as well.

Epic Games buys an abandoned mall

Epic Games announced in early January that it has purchased a 980,000 square-foot abandoned mall in Cary, North Carolina. The 87-acre ruin, known as Cary Towne Center to locals, will be converted to a new Epic Games campus by the end of 2024.

Aside from the sheer scale of the new site, it's not a huge move for Epic Games, which has been based in Cary for over 20 years at its current Crossroads Boulevard location.

"The facilities will include both office buildings and recreational spaces, allowing Epic the flexibility to create a campus customised from the ground up to accommodate its long-term growth," Epic wrote in its announcement.

GAMING NEWS

Riot is working on a *League of Legends* MMO

The company's VP of IP and Entertainment just dropped the announcement on Twitter.

Riot Games is recruiting for a "massive" new game project, an MMO set in *League of Legends*' Runeterra universe. The company's VP of IP and Entertainment, Greg Street, nonchalantly confirmed it on Twitter in December.

"My recent job at Riot has been to help develop the League universe, which we're going to need! Because it is time," he wrote. "My new job is to kick off a big (some might say massive) game that many of you, and many Rioters, have been asking us to create."

When asked bluntly whether the game is an MMO, Street replied: "It is an MMO".

Following Street's tweet, Riot Games PR said in a statement: "Greg's tweet is our only official statement at this time. I can confirm that he will be working on a massively multiplayer online role-playing game (MMORPG)."

CD Projekt investors hit studio with class action suit

Cyberpunk 2077's rocky launch keeps getting rockier.

A lawsuit has been filed against CD Projekt on behalf of its investors for allegedly misleading them about *Cyberpunk 2077*. The game, which released in December, performed terribly on PS4 and Xbox One consoles, prompting Sony to remove the game from sale and issue refunds.

The lawsuit was filed by Rosen Law Firm, a New York based firm that alleges CD Projekt made misleading statements about the game's status on PlayStation and Xbox consoles. After Sony and Microsoft started issuing refunds for the game in the week following its December 13 release date, CD Projekt's stock price fell dramatically despite strong launch sales to the tune of 13 million units.

According to the lawsuit's wording, the company "failed to disclose that *Cyberpunk 2077* was virtually unplayable on the current-generation Xbox or Playstation systems due to an enormous number of bugs."

CD Projekt has opted to defend itself in the lawsuit. In an official statement from the studio, it wrote: "The Company will undertake vigorous action to defend itself against any such claims."

Despite the game's rocky launch, it continues to release patches to improve the game, and at the time of writing the PC, PS5 and Xbox Series X versions of the game run adequately, albeit with bugs.

Alba: A Wildlife Adventure launches on consoles Spring 2021

The team behind *Monument Valley* and *Handle with Care* are back with another chillout game.

Alba launched on Apple Arcade and PC in late 2020 and is developed by ustwo games, who is previously known for other relaxing indie hits *Assemble With Care* and *Monument Valley*.

The game takes place on the sunny island of Pinar del Mar, home to Alba's grandparents who she is visiting for the summer. The island has more than 60 animals inhabitants for players to find, photograph, and even save from tricky situations.

In the trailer, we see Alba exploring the beautiful coast helping maintain the natural balance of the town from repairing bridges, assisting dolphins who have washed up on the shore, as well as photographing and identifying the local wildlife. The game aims to demonstrate to players that even the smallest actions can make a big difference.

Inspired by the development team's childhood memories of coastal Spain, this game has a strong environmental message, with Alba also setting out to stop the destruction of the island's nature reserve.

Mass Effect team reunite as several BioWare veterans join development of new game

Project director reveals which original devs have rejoined the team.

Several of the original *Mass Effect* development team is returning to Bioware for the next installment in the series.

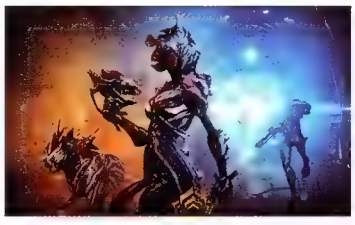
As confirmed by a series of tweets by project director at BioWare Michael Gamble, several key devs including Dusty Everman, Parrish Ley, Brendon Holmes, and Derek Watts will all be working on the latest installment of the series.

These names will be familiar to fans of the *Mass Effect* series. For instance, Derek Watts was the original art director of the series, while Dusty Everman was an original designer, and Parrish Ley was the cinematic director on the original trilogy. On top of this, Brendon Holmes, who is considered an integral part of the BioWare team after working on all four *Mass Effect* games, as well as multiple *Dragon Age* titles, is also returning.

Gamble's Tweets appeared shortly after a new trailer was revealed at The 2020 Game Awards where fans got their first glimpse of *Mass Effect* on the next generation and were given an insight as to what to expect from the series moving forward.

Minecraft and *Doom* are Spotify's most popular game soundtracks for 2020

The new report comes from CNN revealing a slate of new Spotify statistics for 2020. Chiefly, the three most popular game soundtracks over the last 12 months belong to Mojang's *Minecraft*, id Software's *Doom*, and Kojima Productions's *Death Stranding*. The report from CNN doesn't elaborate on which version of *Doom* was responsible for the most streams on Spotify: it could well be 2016's reboot, or 2020's *Eternal*.



Tencent buys *Warframe* developer

Tencent has acquired Leyou Technologies, which owns a majority stake in *Warframe* developer Digital Extremes. Studios under the Leylou umbrella include Splash Damage (*Gears* multiplayer, *Gears Tactics*) and a stake in Certain Affinity, which has worked on titles like *Call of Duty: Modern Warfare Remastered*, and collaborated on *Halo Infinite*.

The acquisition, worth $1.5 billion, is an interesting twist in the Leyou story, which until 2014 was a company focused on chicken processing before pivoting to videogames. As for Tencent, it is now involved in an ever growing number of high-profile games: it owns *League of Legends* company Riot Games, has a 40 percent stake in Epic Games (*Fortnite*), and has a five percent stake in Ubisoft (*Assassin's Creed, Rainbow Six*). ■

Quests
Disrupting the Flow
Mawsworn disrupted
Ashes of the Tower
640/1250 Soul Ash
A Crate of Synvir Ore
Speak with Gibbo at the Old Gate
The Absolution of Souls
Meet the Accuser at Absolution
Bonus Objectives
Stygian Incinerator
0/1 Stygian Incinerator slain
You receive loot: [Shrouded Cloth]x2.
You loot 1 Gold, 78 Silver, 99 Copper
You receive currency: [Stygia] x3.
Imprisoned Soul says: Please... take my blessing.
You loot 1 Gold, 36 Silver, 84 Copper
You receive currency: [Stygia] x5.
Imprisoned Soul says: A taste... of hope

$59 | PC, Mac | worldofwarcraft.com

World of Warcraft: Shadowlands

Another great *WoW* expansion.

Shadowlands is one of *World of Warcraft*'s most ambitious expansions yet. There are times where I feel a little overwhelmed by all of its complex progression systems. When I'm not chipping away at expanding my Covenant's Sanctum, I'm exploring its dark and dangerous new endgame zone or climbing the endless floors of Torghast. And then there's the familiar grind of world quests, dungeons, and chasing down hidden treasures like new mounts.

It's a lot to stay on top of and at times a little too familiar, but much of *Shadowlands*' endgame is varied and inventive enough to keep things fun. It might not win over jaded players who drifted away over the years, but *Shadowlands* is the best *World of Warcraft* has been in a long while.

The new expansion makes some huge improvements over the previous pack, *Battle for Azeroth*. There's no more infinite grind to breathlessly chase. There's no opaque armour system like Azerite Armor to suck the joy out of getting that coveted loot drop from a dungeon boss. And, best of all, a lot of randomness has been dialled back in favour of player choice. Instead of spending weeks praying for a specific, all-powerful Legendary item to drop only to get one that's useless to me, I can farm the materials for the one I want and build it myself. It's empowering to be the one calling the shots instead of feeling beholden to the fickle gods of randomness.

This emphasis on player choice is most evident in Covenants, which are basically Hogwarts' houses if each was a distinct afterlife where souls are sent to live for all eternity. So instead of Slytherin you get Maldraxxus, a hellscape of green where Necrolord armies battle in the Theater of Pain. Or Ardenweald, a cosmic forest where spirits are nurtured in ghost gardens.

All these new factions are introduced through a 15-hour story campaign, but I found it really difficult to care. The quest design is varied but there's no challenge to it, which sucks all the tension out of the story when I melt a big boss in seconds without getting so much as a scratch.

Once players wrap up the story and reach level 60, they'll have to choose one of the four Covenants to join up with. Each one not only offers a different endgame story campaign, but two unique (and very powerful) abilities, armour sets, mounts, and even fun side activities like a soul garden to tend or a forge where you can assemble your own Frankenstein-esque Abominations. It's one of the biggest decisions I've made in *WoW* since choosing my race and class, and I love how much weight it carries.

It may not rekindle a second *World of Warcraft* renaissance, but it's a confident step back in the right direction.

STEVEN MESSNER

Ambitious and grand, if a little uneven, *Shadowlands* is an exciting new step for *World of Warcraft*.

★★★★☆

$53 | PC, PS4, XB1 | dont-nod.com/en/projects

Twin Mirror

A psychological mystery game that fails to go deeper than the surface.

Leaving time travel, telekinesis, and mind reading to the wayside, Dontnod has stepped away from the supernatural themes of its previous games for *Twin Mirror*, a psychological-drama of mystery and conspiracy. This genre of game should be well within the studio's wheelhouse, but unfortunately, Dontnod's first self-published game is a little underwhelming. It has the set up of a great detective mystery, but its unwillingness to explore difficult topics with depth leaves it feeling shallow and half-baked.

Twin Mirror follows Sam Higgs, a former investigative journalist returning to his home town following the death of his best friend and fellow reporter, Nick. It isn't long before Sam gets caught up in a larger conspiracy involving the mining town's community, and he decides to follow the case until the end, which leads him deeper into the underlying secrets of his childhood home. To make matters worse, before he left town two years ago, Sam wrote an article exposing the lack of safety measures in the local mine which led to it being shut down, leaving many people jobless and angry.

There's bad blood brewing and after Sam arrives at the wake, Nick's daughter, and Sam's own goddaughter, confides in him that she thinks something about her father's death feels off. Presented with the possibility that his friend's death may have had a sinister dimension, Sam agrees to investigate.

Even though the evidence gathering is flakey, I went into the rest of the game excited to uncover the secrets of the sleepy town of Basswood, but unfortunately the investigation never really cranks into gear – it barely gets going at all. Even after Sam is confronted by angry townsfolk who are suffering because of his mine safety article, he never really engages with it head-on.

Never exploring these themes beyond the surface pretty much sums up *Twin Mirror*. From its vapid minigames to lacklustre dialogue, it never delves that deep into the topics it attempts to grapple with.
RACHEL WATTS

Kicks things off with an intriguing set-up but, disappointingly, ends up going absolutely nowhere with it.
★★½☆☆

Free | PC | papercookies.itch.io/chain

C.H.A.I.N.

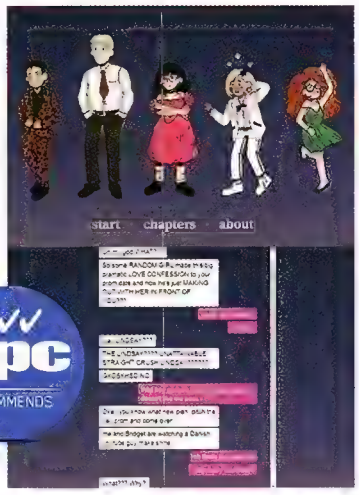
An anthology by relay in surreal horror.

The concept behind *C.H.A.I.N.* is fascinating. It's a daisy chain of interconnected horror games: 20 games from 20 developers, each of whom had only an inkling of what the other games were about. It begins with Torch (or, if you like, Specimen #01), a simple establishing shot that plonks a woman inside a tomb, and that ends with an ominous door opening.

At that point, the game was passed along to the second developer in the daisy chain, who continued the story, as they saw it, with another short game bearing the popular PlayStation aesthetic. And so it went until 20 games had been created, and half a year had passed. The collection was ultimately bundled as *C.H.A.I.N.*, which has some of the most gorgeous presentation of any anthology.

There's a lot of grainy, pixellated, first-person horror. You might be traipsing around a forest, or dodging ghosts in a library, or traipsing round another forest. This is route-one 'spooky PS1 anthology' stuff until all that remains is a vague through-line about cursed books and roaming monsters. TOM SYKES

An experiment that starts out full of promise, and ultimately goes nowhere. But it's still a journey worth taking.
★★★☆☆



Free | browser | bphennessy.itch.io

Boat Prom

No birds or land.

Brendan Patrick Hennessy's acclaimed interactive fiction game *Birdland* gets a sequel in *Boat Prom*, which is about a prom that takes place on, er, a boat. Playing as Elizabeth Wei, a character from *Birdland*, you have to handle a humiliating rejection, while the people around you are having the time of their lives.

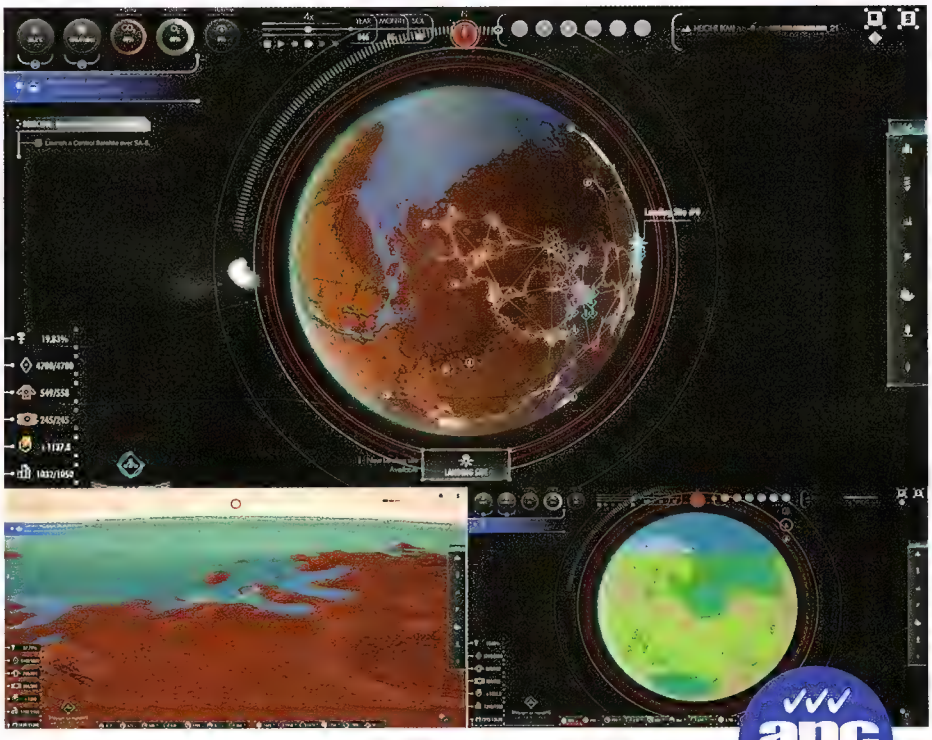
This is all about the dialogue, which is some of the most effortlessly funny and lifelike in the business. With just a few stage directions, and an economical word count, Hennessy has created a diverse cast of distinct and quotable characters, including sullen protagonist Elizabeth, who manages to be self-pitying without being annoying – a spectacular feat of writing that probably deserves all the awards it can be given.

Like most media to do with the prom, *Boat Prom* is about relationships. Stinging from that very public rejection, Liz spends her time alternately sulking and railing at the girl she holds responsible, while her friends try to console or distract her. I won't spoil how the story develops, but rest assured that it ends satisfyingly.

TOM SYKES

It's worth replaying the game to witness all the brilliant dialogue.

★★★★☆



$43 | PC | per-aspera.vg

Per Aspera

Terraforming Mars and making friends.

Per Aspera is a novel combination of planetary science simulator, hardcore management game, and dynamic narrative experience. You play as a newly awakened artificial consciousness, AMI, whose job is to establish an autonomous colony on Mars, and ultimately terraform the planet to make it suitable for 'Earthian' life long-term. AMI's story plays out in audio transmissions voiced by a star-studded cast, with standout performances by the likes of Laila Berzins, Troy Baker, and Phil LaMarr. It's a series of moral choices that lead to one of several different game endings.

Most of *Per Aspera* is about panning around a beautifully rendered topographical globe of Mars and listening to a chill ambient and upbeat techno soundtrack. Your view is AMI's, a vector interface with lots of soft edges and sans-serif fonts.

You survey for minerals and establish mines to retrieve resources like aluminium, carbon, silicon, or buried water. You build factories to transform these resources into finished materials like electronic components, and then into further buildings and equipment like worker or repair drones, or space projects like reflective mirrors. Scarcity is concern number one in *Per Aspera*. Build in the wrong order? That might well be game over.

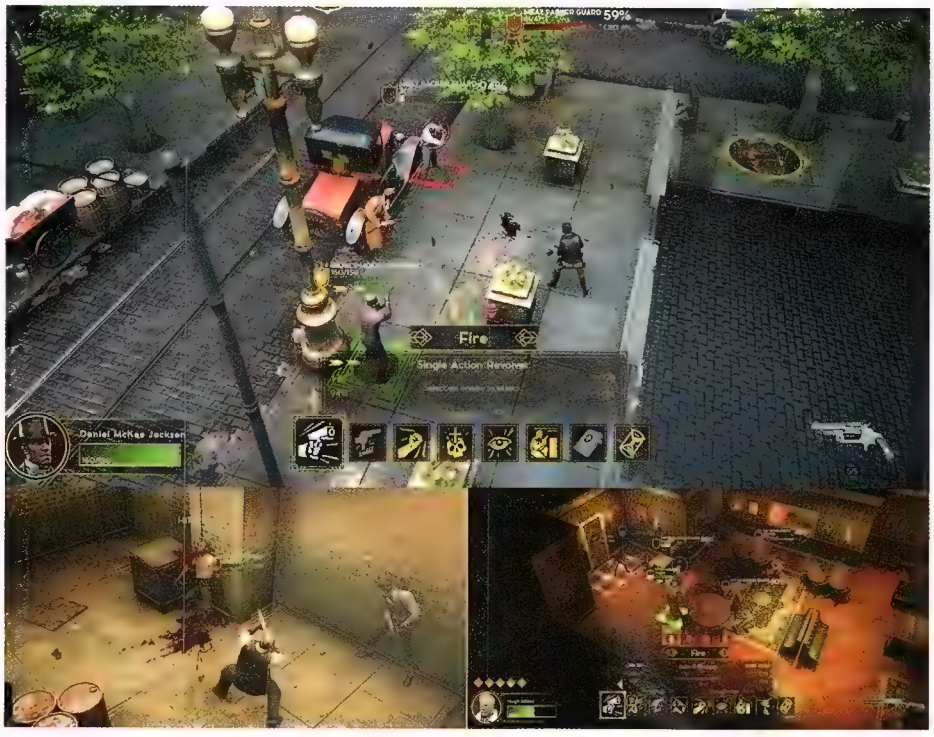
It's one of the most demanding games I've played in a long time, not just in its complexity but in its mental and reaction time demands on you as a player. Playing, my fingers constantly slid between WASD for the camera, the numbers for game speed, and the function key overlays for power, maintenance, drone traffic, or survey results. *Per Aspera* is a 'blink and it's 3.00am' game.

It's not only a detailed strategic simulation, but also a sweeping sci-fi tale that fits the massive nature of the job you do in it. It's got some technothriller intrigue, but it also takes big idea sci-fi seriously, grappling with the nature of artificial consciousness and the ethics of terraforming a new world. Combined with terraforming, slick aesthetics and classic genre gameplay, this is worth the time.

JON BOLDING

Hard science, harder simulation, and narrative innovation make Tlön Industries' *Per Aspera* an absolute gem.

★★★★☆



$53 | PC, Mac, PS4, XB1, Switch | empireofsingame.com

Empire of Sin

Ambitious, but undermined by a mountain of issues.

Empire of Sin makes a good first impression. It's clearly born out of a fascination with the prohibition era, and as a management game it tries to capture the breadth of the illegal businesses and shady deals that kept these underground empires going – but it's even more interested in the people that join and run them. It's as much an RPG, and each boss has their own storyline and missions that lets you shape the kind of crook you want them to become.

Sit-downs are where *Empire of Sin*'s criminal cast really gets to shine, letting you meet rival bosses to shoot the shit and make deals. They're hammy and immensely fun conversations, taking advantage of each gangster's personality and history to create memorable verbal sparring matches. The illusion is shattered, unfortunately, when they offer completely random deals with terms that contradict each other, or when you realise that every deal is just a straightforward buff that costs you nothing.

Developing your boss and making deals is still a lot more entertaining than sitting at a desk, staring at messy art deco menus and stark maps. The day-to-day management of even the most crooked of casinos is not particularly scintillating, and while there are a few different ways to ensure your businesses flourish, like matching the booze to the affluence of the area, success mostly amounts to hostile takeovers and pouring excess cash into upgrades. Constant, unrelenting expansion is what wins the day, not business smarts. You're pushed to play aggressively, but doing so effectively neuters the entire management layer. Instead of supporting each other, the systems end up fighting for attention and pushing others out of the way.

Empire of Sin is an ambitious management game that never manages to tie together its big ideas. There's a version of it in there somewhere that's good, but this one is just a bit of a mess. The potential is obvious, but it hasn't been realised.

FRASER BROWN

Empire of Sin's many bugs and competing systems undermine what could have been a novel mob management game.

★★½☆☆

Free | PC, Mac | bastinus-rex.itch.io

Hamelin

Hmm, must have been rats.

Bastinus Rex's *Hamelin* reimagines the tale of the pied piper – or possibly offers a sequel to it. As the rat-diverting, child-abducting wrong'un prepares to be burnt at the stake, you have to scuttle around to rescue him, avoiding guards and joining forces with your similarly bewhiskered colleagues.

Hamelin is a couple of short levels of rodent-based stealth, bookended at either side by cutscenes. The first level sees your rat skittering away from a few striding guards, and up onto the eaves of a church. It's a lovely scene, strikingly lit and with some satisfying sound design – like a single room from *Thief* shown from a rat's eye view. As you proceed, you're taken to Stage 2, which is a hell of a lot more frustrating.

In this more open space, you have to meet up with your ratty chums, while dodging the guards dotted around the piper's bonfire. If they see you, they'll inevitably catch up, and introduce you to the underside of a boot.

TOM SYKES ■

A game that is novel and rife with atmosphere.

★★½☆☆

I defeated this boss by clicking on it once and then eating rabbit sandwiches.

DEVELOPER JAGEX **PUBLISHER** IN-HOUSE **RELEASED** 2001 **WEB** runescape.com

Runescape

Nearly two decades old, it has never stopped growing.

In 2001 *RuneScape* launched as a browser game and never stopped moving forward, depositing old versions along the way for players who wanted to stay in the past: *RuneScape Classic*, which no longer exists, and then *Old School RuneScape* in 2013. For everyone else, the modern version is just called *RuneScape*, and was recently added to Steam. I've always had the sense that *RuneScape* is a bit esoteric (I'm sure I tried it back when it launched, when I was into MUDs and other relics of online gaming), but I didn't realise just how weird the free-to-play MMO is until I gave it a try. Nearly two decades after it first released, visiting *RuneScape* is like entering a PC gaming pocket dimension that split off from our own years ago, perhaps accessed by passing through the infinite loop of a GeoCities webring.

Like any other MMO, *RuneScape* begins with character creation, and I design a bearded man with a bald-on-top monk cut. I have no name in mind for him, so I opt to let *RuneScape* generate a random one. I'm expecting it to hit me with something fantasy-ish, like Illhard Earling or Haglbar or Revvyn. It suggests Deathlum1934. I hit the randomise button again. 59Bork2396. Again. Dingo2429. 44slender392.

Clearly, randomised names are not *RuneScape*'s strength. No problem: I type in the name of German author WG Sebald. It tells me that someone has already taken the name WG Sebald. Who could possibly be running around *RuneScape* as German literary figure WG Sebald? I don't know, but the game's been around for nearly 20 years now, so I should've figured that no niche would be untouched. I type in Burrp Bram and the name is accepted. I am now Burrp Bram.

In the tutorial area, I learn there's a skill called Prayer and that burying the bones of my slaughtered enemies will increase my Prayer skill. Later, those enemies include innocent tutorial bunnies that I stab to death with a dagger and make sandwiches out of, innocent tutorial cows that I pierce with arrows while they helplessly bustle about a pen, trolls who live in caves directly beneath the town, gelatinous abominations, and some skeletons, who were presumably buried at one time, and now need to be reburied.

I bury all their bones, even the bones of the gelatinous abominations, which somehow have bones. I level up my Prayer skill in the process, although I don't bother to learn what Prayer actually does. I've never been very patient with tutorial text.

My new friends: Yeti dad and his daughter Violet.

PRAYER INSTRUCTOR
Yes. In general, always try to be courteous to others - remember that adventurers like yourself are real people with real feelings. If you go around being abusive or causing trouble, you could end up in trouble.

Learning how to bury bones, as everyone does in church.

RECURSIONS

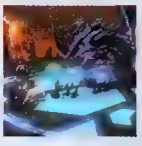
Two decades of betas, renamings, and rereleases

January 2001 *RuneScape* launches.

March 2004 *RuneScape 2* becomes *RuneScape*. The old version becomes *RuneScape Classic*.

April 2013 The *RuneScape 3* beta goes live.

July 2013 *RuneScape 3* becomes *RuneScape*.



October 2020 *RuneScape* releases on Steam.

December 2003 The *RuneScape 2* beta begins.

February 2013 *Old School RuneScape* launches, bringing back a version of the game from 2007.

April 2016 A new game client is released.

August 2018 *RuneScape Classic* closes. Jagex delays the shutdown to let one player finish the Legends' Quest.

Early 2021 The Steam release window for *Old School RuneScape*.

Meeting death

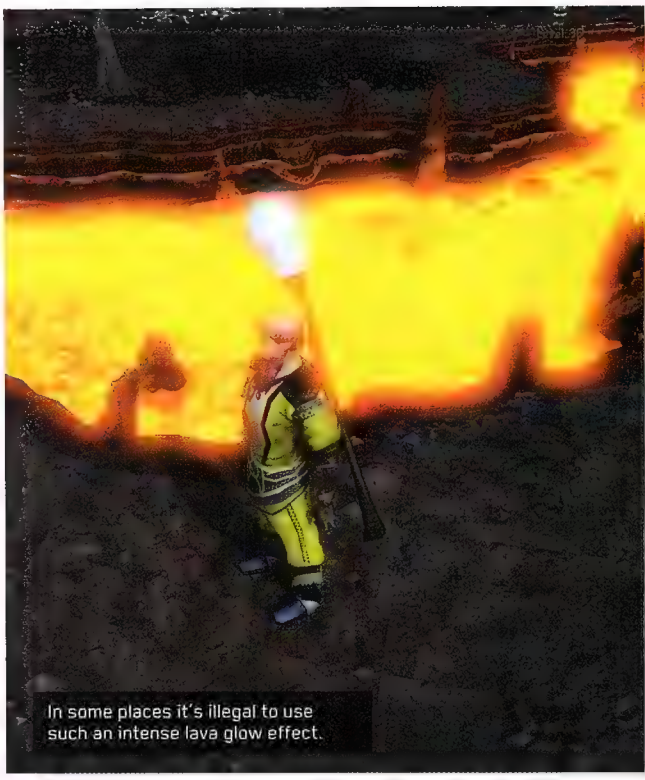
When *EverQuest* launched, my favourite thing to do was explore the world with low-level characters, danger be damned. It was about the adventure, not the grinding, and I'm happy to discover that *RuneScape* offers the same freedom. I quickly brush aside all of the tutorial work I was supposed to do, despite barely understanding the arcane, semi-automated combat system and spell rune economy (in those respects, *RuneScape* feels very much like a game that's been under construction for 20 years), and just start walking.

Almost immediately, I run into Death himself, skeletal and floating. He turns out to be a nice guy – clearly hanging out as part of a Halloween event – and he informs me that at the beginning of every hour there's a chance it'll become a 'spooky hour', which increases XP earned. I think that could be true of life, too. Maybe you're in a spooky hour right now. Feels like it.

Death also gives me my first real quest, handing me a crystal that he says will guide me to lost souls that need to be defragmented. That's the word he uses: 'defragment'. Like they're hard drives. I think that souls these days really ought to be stored on SSDs, but I run off to the Barbarian Village to the north to defragment my first one. I'm kind of worried the identical blonde barbarians will attack me, but they just mill around with spears while I chase down a glowing soul dot and click on it to heal it. As I do, my mind is "flooded with images of axes, blood, and fists". And then, when I've nearly finished defragmenting the soul, my mind is "filled with pictures of a burial, fires and a trial". Ostensibly, this is a game for kids.

After saving the soul – but not through Prayer, interestingly – I decide to move on from Death's task (clicking on a glowing dot is not all that fun, actually) and go further north. I arrive at the ruins

At some point, every MMO character finds himself mining some tin.


In some places it's illegal to use such an intense lava glow effect.

of a wall, and when I try to cross it, *RuneScape* warns me that I'm entering the Wilderness, where other players can attack me. I have nothing to lose, so I hop in. I admire a river of lava, and then run further north and get killed by ranged attacks from a beast I hardly get a look at. I nearly survive by eating all of my rabbit sandwiches as I run away, but not quite.

Yeti trouble

After I respawn, I figure I'm wasting my time and I ought to just go back to the first town and play the game properly, focusing on levelling. But the big unexplored map calls to me, so I start travelling east and eventually I do discover something: a little girl sitting outside of a portal. When I talk to her, she bolts through the magic gateway.

The ground on the other side of the portal is covered with untouched snow. A forest of evergreens goes on forever. Violet, the kid, starts rolling Indiana Jones-style balls of snow down a hill at me. I have to run up the slope while avoiding the enormous snowballs, which is difficult because movement is done by clicking on a destination, and my character likes to complete movement one axis at a time rather than taking diagonal paths. After several attempts, I make it to the top and Violet runs away. I'm curious, now. I'd assumed that only high-level players could survive a mysterious portal adventure, so I'd expected to die near instantly at the hands of a Yeti or some other monster.

It turns out there are two Yetis in the snow world, but they don't want to kill me. A minute later, I'm standing in their house talking with them about their adopted human daughter, who's sulking about a Yeti festival she's not allowed to attend. Violet's parents are worried the other Yeti kids at the festival will make fun of her because she's a human. For some reason, Yeti dad will only let her attend if I go with them. From

BURRP'S TRAVELS

A little jaunt through a big world

1 LUMBRIDGE
Full of peaceful goblins and spiders. Some humans.

2 DRAYNOR MANOR
Met Death here. Learned about 'spooky hours'.

3 BARBARIAN VILLAGE
Three identical blonde women with spears marched around me in a circle. Defragmented a soul.

4 WILDLANDS
Should have turned around when I saw the rivers of lava. Died.

5 LAND OF SNOW PORTAL
There's probably some kind of bizarre Yeti-related quest on the other side of this.

Choose a Path...
At the start of each hour, there is a chance it'll become a spooky hour. All experience gained within the Draynor Manor grounds during this hour will be increased by 1-5% (Increased by completing Death's, Famine's, Pestilence's & Muncher's miniquests)
Death explains the concept of spooky hours.

here on, it kind of feels like I'm undergoing some kind of psychological evaluation.

Our first obstacle is a dark stretch of trees that Violet refuses to traverse due to the possibility it contains monsters. We can't move forward until I find a way to create some light for her. I shake a bush and a firefly emerges. I click on the firefly to catch it in my hands, and then I give it to Violet. She immediately eats it.

According to Violet, fireflies taste like "popping candy" and provide a "warm feeling" in her tummy, and I'm assured that any further fireflies I hand to her will be instantly eaten. She is simply unable to square her desire for light with her desire to eat fireflies, so I have to come up with a new solution. It's pretty simple: just make a spigot, stick it into a maple tree, collect maple syrup in a bucket, spread the syrup on trees along the path, ask Violet's dad for an empty bottle (this took me forever to figure out, but I wonder if a kid would instinctively ask the adult for help?), fill the bottle with fireflies, and then give the bottle to Violet so that she can let the fireflies out as we walk. The theory is that the fireflies will not be eaten by Violet because they are in a bottle, but they will be attracted to the maple syrup on the trees, providing a steady source of light.

After that, we encounter a group of ice elementals, and I think, here we go, a combat encounter that'll surely kill me because I haven't levelled at all, but no, that's not the case. I have to build snowman heads that match Violet's facial expressions and then help her throw them onto the elementals, because they have no heads of their own, and she refuses to leave them headless.

Strange old world

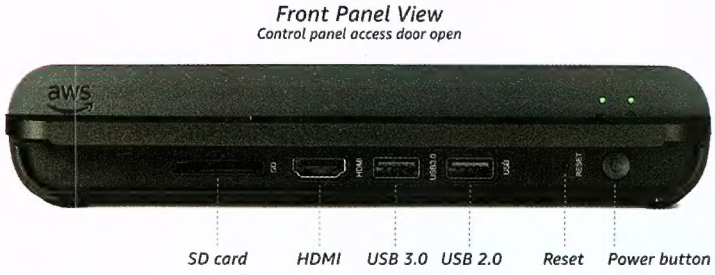
It turns out that Violet's quest was added as part of the 2018 Christmas event. These things are just left behind for new players to discover – not like *Destiny 2* and *World of Warcraft* and other games, which are culled and streamlined. My chance meeting with Death? It turns out his full name is Harold Death, Esq, and he doesn't just show up for the week of Halloween. He lives in a big mansion where he frequently kills servants accidentally, due to his touch of death. I said that *Runescape*'s combat systems feel like they've been under construction for 20 years – well, so does the rest of *Runescape* (except maybe the graphics, though they have been).

In some ways, Runescape feels like a precursor to Fortnite – they've both built up a patchwork of lore over time, and theoretically being 'for kids' hasn't stopped them from being weird, complex, and sometimes unsettling (that poor barbarian soul). But *Fortnite* will be carefully manicured in the way live service games are these days, and I doubt it'll ever be allowed to grow gnarled, tangled fingernails quite like *Runescape*, which you'll recall involves performing religious burials. The idea of holding funerals for fallen enemies in *Fortnite* was a *ClickHole* joke. Two decades after it launched, *RuneScape* is still ahead of its time.

TYLER WILDE ■

CHIP CHAT

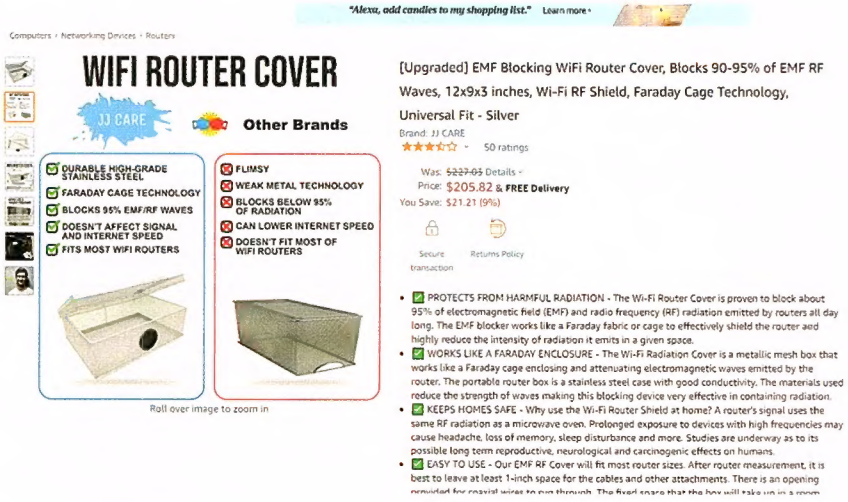
JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS



Trades Union Congress concerned over new Amazon edge computing cameras

Amazon Web Services releases new cameras to watch employees.

Amazon is attempting to sell a new edge computing device that'll allow employers to check in on staff to see if they're adhering to COVID Safe practices ... and, well, potentially lots of other things too. Amazon is pitching its AWS Panorama box as an AI unit that can be retrofitted to cameras to do things like count the number of people in a shop to ensure there's never a breach of public health rules, but a report by the UK Trades Union Congress argues that COVID-19 safety protocols are just the latest excuse to further erode worker's privacy.


"Alexa, add candles to my shopping list." Learn more
Computers › Networking Devices › Routers
WIFI ROUTER COVER
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Other Brands
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FARADAY CAGE TECHNOLOGY
BLOCKS 95% EMF/RF WAVES
DOESN'T AFFECT SIGNAL AND INTERNET SPEED
FITS MOST WIFI ROUTERS
FLIMSY
WEAK METAL TECHNOLOGY
BLOCKS BELOW 95% OF RADIATION
CAN LOWER INTERNET SPEED
DOESN'T FIT MOST OF WIFI ROUTERS
Roll over image to zoom in
[Upgraded] EMF Blocking WiFi Router Cover, Blocks 90-95% of EMF RF Waves, 12x9x3 inches, Wi-Fi RF Shield, Faraday Cage Technology, Universal Fit - Silver
Brand: JJ CARE
50 ratings
Was: $227.03 Details
Price: $205.82 & FREE Delivery
You Save: $21.21 (9%)
Secure transaction
Returns Policy
PROTECTS FROM HARMFUL RADIATION - The Wi-Fi Router Cover is proven to block about 95% of electromagnetic field (EMF) and radio frequency (RF) radiation emitted by routers all day long. The EMF blocker works like a Faraday fabric or cage to effectively shield the router and highly reduce the intensity of radiation it emits in a given space.
WORKS LIKE A FARADAY ENCLOSURE - The Wi-Fi Radiation Cover is a metallic mesh box that works like a Faraday cage enclosing and attenuating electromagnetic waves emitted by the router. The portable router box is a stainless steel case with good conductivity. The materials used reduce the strength of waves making this blocking device very effective in containing radiation.
KEEPS HOMES SAFE - Why use the Wi-Fi Router Shield at home? A router's signal uses the same RF radiation as a microwave oven. Prolonged exposure to devices with high frequencies may cause headache, loss of memory, sleep disturbance and more. Studies are underway as to its possible long term reproductive, neurological and carcinogenic effects on humans.
EASY TO USE - Our EMF RF Cover will fit most router sizes. After router measurement, it is best to leave at least 1-inch space for the cables and other attachments. There is an opening

People putting routers in Faraday cages to protect from 5G

These EMF shields will only stop the 'bad' EM radiation.

We spent a bit of time debunking the concerns people were having about 5G reception towers last year, but the standard Wi-Fi spec for the last five years has also used a 5GHz frequency to relay your local area network and a few savvy amazon businesses are trying to cash in on the connection. Take the $205 EMF Blocking router cover from JJ Care, which happens to be a $5 metal desk organiser with a cable hole cut in it. While many of the reviewers found that this metal faraday cage stops all Wi-Fi functionality (funny that) others have taken the ingenious step of cutting holes in it to regain Wi-Fi capabilities.

Millennials get financial advice from Tik Tok

Financials can be a pretty boring topic and short entertaining videos are an effective way to engage a broad audience of young viewers, but as the last couple of years has shown, social media has a complex relationship with the truth. There are plenty of worthwhile Tik Tok lessons to be found under the 2020 trending hashtags #investing and #sidehussle, but some of the most popular posts are actually wrong or, sometimes, intentionally misleading. Joke accounts like @kingzippy have posted humorously about schemes to cycle between credit card accounts for never ending credit and naive TikTok users like 14h.ryan have recommended 970% returns from stocks like Callon Petroleum which actually just diluted stock and did not increase in market value at all.

Japan invests in AI dating apps to boost birth rate

With international travel all but dead, countries that rely heavily on immigration to stabilise low rates of population growth are looking to other means to keep their economy afloat. Japan, for example, is investing ¥2bn (AU$25.5 million) in digital dating services powered by AI matchmaking technology in order to spark its very own baby boom. Prime Minister Yoshihide Sugra said that while dating apps have been around for some time, AI matchmaking offers the additional advantage of finding better suited partners that are more likely to make babies. What could possibly go wrong? ■

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REPUBLIC OF GAMERS

THE CHOICE OF CHAMPIONS

BEHOLD THE BEASTS

ASUS RADEON™ RX 6000 SERIES

ROG Strix

This frame-crunching colossus is a ferocious blend of industry-leading Axial-tech cooling, high-end power delivery , and a plethora of creature comforts. The ideal choice for air-cooled gaming rigs.

ROG Strix LC

Deep in ASUS R&D labs, engineers theorized the optimal thermal solution for AMD's latest RDNA™ 2 Architecture. The beast that emerged is a liquid-cooled leviathan capable of drawing maximum performance out of the new chips, while remaining completely cool and quiet.

TUF Gaming

This tenacious beast boasts a tough metal exterior, super-efficient cooling, and TUF components selected for maximum durability. It's a mean machine ready for unbridled action for years to come.

ASUS